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# A Computational Model for the Prediction of Jet Entrainment in the Vicinity of Nozzle Boattails (The BOAT Code)

## Program Users Manual

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In what follows we first discuss the basic code structure, including the overall program flow and a brief description of all subroutines. This is followed by instructions on the preparation of input data, definitions of key Fortran variables, sample input and output, and a complete listing of the code.

# 3. BASIC CODE STRUCTURE

## 3.1 Overall Subroutine Flow Chart[†]

Fig. 3.1 shows the overall program flow, which is divided into input (S1) and integration (M1) routines. Input is via cards or from a restart file (RS) which is automatically created as the calculation proceeds. If an output flowfield file is being created for input to the A.R.A.P. radiation code (STARAD), LU will either set up the file for starting a run or read the file which already contains flowfield information, for a restart run. IF, II, and LI are used for inputting and processing inviscid flowfield data maps, while IP establishes initial profiles of velocity, temperature, etc. for program-calculated profiles. IN prints all input data.

In the integration routine, S3 solves the finite difference equations, utilizing output from VI for the turbulent viscosity, CC for the chemical reaction rates, and SL to invert the matrix formulated in the implicit solution of the species continuity equation. OT is the output routine and all the resetting of variables, and step size controls are performed in M2. EN calculates the mass entrained at each integration step while DS calculates the displacement thickness and position of the "effective plume boundary" for use in NASA/LRC boattail pressure calculations. TK and LP are interpolation routines while CP is used to save common and the flowfield files for use in restarting the program.

Additional details on these subroutines are given below.

## 3.2 Subroutine Description

BOATCC — Uses input on chemical reaction rates from S2 to set up appropriate terms in the matrix, which is to be inverted for solution of the species continuity equations.

BOATCP — Saves common and flowfield files (if created) for use in restarting calculations.

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[†]All subroutine names contain BOAT followed by two alpha-numeric quantifiers. The BOAT precedent is deleted in the descriptive paragraphs below.

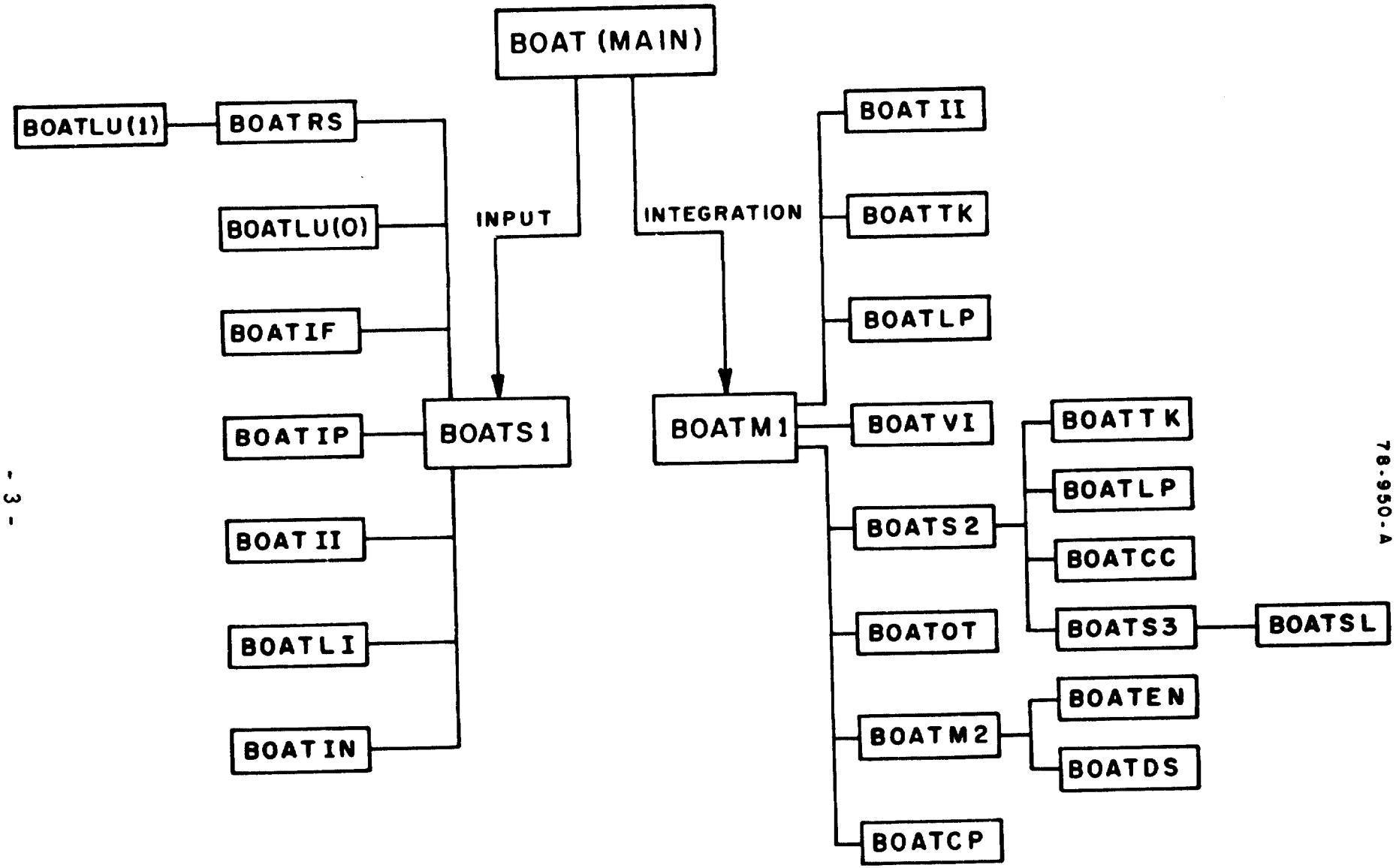


Figure 3.1 BOAT code subroutine flow chart

BOATDS — Calculates "effective" plume shape (due to jet entrainment effects) for use in external inviscid subsonic/transonic flowfield calculations.

BOATEN — Calculates shear layer growth rates from entrainment rules yielding values of $\psi_1$ (PSII) and $\psi_2$ (PSIE) at the new station, $x + \Delta x$.

BOATIF — Generates vector arrays VJET (J, K, L) and VEXT (J, K, L), containing the user-specified inviscid exhaust solutions, in mapped streamline coordinates. The J index refers to the dependent variable (1 = Y, 2 = P, 3 = T, and 4 = U); the K index to the radial grid point (for the jet exhaust, K = 1 is the axis and K = KMAXJ is the plume interface; for the external flow, K = 1 is the plume interface and K = KMAXE is an arbitrary upper boundary); the L index refers to the axial station XJET(L) for the jet and XEXT(L) for the external flow.

BOATII — Yields properties from the mapped vector arrays VJET and VEXT by interpolative procedures. BOATII has the calling sequence BOATII (ITYP, XX, PSIX, IMAXV, KMAXV, IV, VECT, XV, PSV, V1, V2, V3, V4, PSJ, FID, NREC). ITYP = 1 or 2 indicates that a standard jet or external flow interpolation for a local property will be made, while ITYP = 3 or 4 indicates that an interpolation for axial gradients of the jet or external flow variables will be made.

XX is the value of X at which the properties are desired and PSIX is the value of the streamfunction, $\psi$.

IMAXV is the total number of jet (IJET) or external flow (IEXT) stations and KMAX the number of processed data points at these stations (KJET or KEXT).

IV is the index of the inviscid mapped station such that XV(IV-1) $\leq$ XX $\leq$ XV(IV) where XV is either XJET or XEXT.

VECT is either VJET or VEXT while PSV is either the jet exhaust mass flow, $\psi_j$(PSJET), or the external flow value of $\psi_e$(PSEXT).

V1, V2, V3, and V4 are Y, P, T, and U respectively.

BOATIN — Prints all pertinent initial data, the chemical reaction mechanism, etc.

BOATIP — Calculates initial shear layer or boundary layer profiles if the user does not specify initial data profiles.

BOATLI — Interpolates in mapped vector arrays for property values

BOATLP — Interpolates for thermodynamic properties at the local temperature

BOATLU — Used in setting up or reading flowfield files for input to the STARAD code (only for NRAD = 1)

BOATMI — Controls the overall integration process via the following sequence of calls and operations:

- o The auxiliary dependent variables CPBAR, HSTAT, and Y are determined.
- o The turbulent viscosity is determined via a call to BOATVI.
- o The allowable step size, $\Delta x$, is established.
- o Edge conditions at the new station are determined from the inviscid data map via calls to BOATII.
- o The integration procedure is initiated via a call to BOATS2.
- o BOATOT is called to print flowfield profiles at the user specified print intervals.
- o The program is terminated if the axial station exceeds XMAX.
- o The main dependent variable arrays are reset into the initial profile locations via a call to BOATM2.
- o Run and job times are compared with user specified times and the above sequence is repeated if no time limits are exceeded.

BOATM2 — Primary functions are to perform step size checks and to reset dependent variables after an integration step has been taken. The following specific operations are performed:

- o A check is performed to determine whether the temperature change along each streamline has exceeded the maximum allowable change, TCONT. If so, the step-size, $\Delta x$, is halved and the integration process is repeated.
- o A check is performed to determine whether any mole fractions become negative in the integration step. If so, the integration process is repeated with a halved step-size as above.
- o The mass entrainment for the next integration step is determined from the newly calculated profiles via a call to BOATEN.
- o The calculated dependent variables RU, RT, and RALPHA are reset into the initial arrays U, T, and ALPHA in an interval extended by the mass to be entrained in the next integration step.

BOATOT — Prints out properties at all radial points at print intervals, PRNT or PRNTXC.

BOATRS — Reads in common and flowfield file (for STARAD radiation code input), via call to BOATLU, for restarting a calculation.

BOATSL — Solves the system of linear equations generated by the implicit chemistry calculational procedure using a Gauss-Gordon reduction algorithm with diagonal pivot strategy.

BOATS1 — Main initialization routine which establishes profiles of the dependent variables U, T, and ALPHA in evenly spaced streamfunction coordinates; also reads and processes thermochemical and inviscid flowfield data. The following sequence of operations is performed:

- Parameters controlling the run type, grid resolution, print interval, etc., and array of the dependent variables and/or edge conditions at the initial station are read.
- Inviscid flowfield data are read and processed into mapped evenly spaced arrays via a call to BOATIF.
- If initial profiles are not read, a call to BOATIP yields either shear layer or boundary layer starting profiles.
- The dependent variable arrays are recast into evenly spaced arrays in streamfunction coordinates.
- BOATIN is called, which prints pertinent initial data and lists the chemical reactions considered in the calculation.

BOATS2 — Together with the subsidiary subroutines BOATCC, BOATEF, and BOATTK, this routine comprises the chemical integration package. BOATS2 additionally calls BOATS3 for each grid point to integrate the flowfield equations.

BOATS3 — Contains the finite-difference formulation of the axial momentum, energy, and species diffusion equations. BOATS3 integrates the momentum and energy equations by an explicit procedure and the species diffusion equation by an implicit procedure, calling BOATSL to solve the resulting system of linear equations.

BOATVI — Calculates the turbulent viscosity, XMU, for all grid points using either: (1) the Prandtl Mixing Length Model with duel length scale provisions for velocity maxima or minima at interior points, (2) the 2-equation, $k\varepsilon 2$, turbulent kinetic energy model or (3) the Donaldson/Gray eddy viscosity formulation.

## 4. INPUT DATA PREPARATION

| Column | Fortran Name | CARD 1 |
|---|---|---|
| 1 (I1) | ITYPE | = 0 restart, = 1 new run |
| 3-8 (3A2) | IFNAM | restart file name |
| 10-15 (3A2) | NAMAS | flowfield file name - used for input to STARAD radiation code |
| 17-26 (F10.0) | RTMAX | overall run time (minutes) |
| 27-36 (F10.0) | RTJOB | job time (minutes) |

| Column | Fortran Name | CARD 2 |
|---|---|---|
| 1-72 (18A4) | TITLE(I) | job identification |

| Column | Fortran Name | CARD 3 |
|---|---|---|
| 1-5 (I5) | MPSI | number of radial data points in user specified initial profile (IDELP = 1); number of points for run in other initialization options (IDELP = 0, -1) (maximum of 50) |
| 6-10 (I5) | NMPSI | number of points for run if initial profile is user specified (maximum of 50); for other options set NMPSI = MPSI |
| 11-15 (I5) | NS | number of gaseous species (maximum of 25) |

CARD 3 (continued)

| Column | Fortran Name | |
|---|---|---|
| 16-20 (I5) | NR | number of chemical reactions (maximum of 25) |
| 21-25 (I5) | NT | number of temperatures at which thermodynamic data (Card 15) are defined (usually, NT = 22, maximum of 30) |
| 26-30 (I5) | IDELP | indicator for specifying initial radial profiles<br>= 0; shear layer profile calculated internally<br>= 1; user specified profile<br>=-1; boundary layer profiles calculated internally |
| 31-35 (I5) | IPRESS | inviscid structure indicator<br>= 0; constant pressure mixing<br>= 2; BOAT overlaid on inviscid solution; inviscid property data maps of plume and external flow must be input on Cards 17 and 18 |
| 36-40 (15) | IVIS | turbulence model indicator<br>= 0; Prandtl Mixing Length Model<br>= 1; Donaldson/Gray Model<br>=-1; $k\varepsilon 2$ two-equation model (initial turbulent kinetic energy profile calculated internally)<br>=-2; $k\varepsilon 2$ two-equation model (initial turbulent kinetic energy profile specified on Card 13) |
| 41-45 (15) | IMAXJ | number of axial stations input for jet exhaust inviscid data map (maximum of 50) |
| 46-50 (15) | KMAXJ | number of mapped radial stations desired in jet map (maximum of 25) |

| Column | Fortran Name | CARD 3 (continued) |
|---|---|---|
| 51-55 (I5) | IMAXE | number of axial stations input for external flow inviscid data map (maximum of 50) |
| 56-60 (I5) | KMAXE | number of mapped radial stations desired in external flow map (maximum of 25) |
| 61-65 (I5) | IOUT1 | chemical production terms ($\dot{w}$) output indicator<br>= 0 no output<br>= 1 $\dot{w}$ terms output for each species |
| 66-70 (I5) | IOUT2 | production/depletion (RP/RM) terms output indicator<br>= 0 no output<br>= 1 RP/RM output for each reaction |
| 71-75 (I5) | NRAD | flag to generate radiation output tape<br>= 0 no output file for radiation code<br>= 1 flowfield output file generated for input to STARAD radiation code (file name on Card 1) |

| Column | Fortran Name | CARD 4 |
|---|---|---|
| 1-10 (E10.3) | X | initial axial station (ft), cannot be 0 for IDELP = 0, typically X = 0.1 RJ |
| 11-20 (E10.3) | RJ | nozzle exit radius (ft) |
| 21-30 (E10.3) | XMAX | total length of run (ft) |
| 31-40 (E10.3) | PRINT | print interval (ft) |

CARD 4 (continued)

| Column | Fortran Name | |
|---|---|---|
| 41-50 (E10.3) | XCHANG | change print interval at this axial location (ft) |
| 51-60 (E10.3) | PRNTXC | new print interval (ft) |
| 61-70 (E10.3) | FDL | multiplies program calculated step size, $\Delta x$, in order to reduce step size. Useful in initial regions with steep gradients (e.g., initial boundary layers); typical value for initial boundary layers; FDL = 0.2, to supress oscillations. For smooth initial profiles set FDL = 1.0 |
| 71-80 (E10.3) | DFDL | at each step, DFDL is added to FDL until FDL = 1.0. In problems with initial boundary layers, FDL = .2 and DFDL = .05 should prove adequate |

CARD 5

| Column | Fortran Name | |
|---|---|---|
| 1-10 (E10.3) | XLE(1) | turbulent Lewis number |
| 11-20 (E10.3) | SIGMA(1) | turbulent Prandtl number |
| 21-30 (E10.3) | TCONT | maximum allowable temperature change permitted in an integration step (°K); typically, $5° \lesssim$ TCONT $\lesssim 10°K$ |
| 31-40 (E10.3) | TKINET | chemical kinetics cut-off temperature-chemistry assumed frozen below this value. (If TKINET = 0, the default value of 400°K will be used.) |
| 41-50 (E10.3) | CARBON | use only if writing output to file for use in radiation calculations with solid carbon in plume. If CARBON = 1.0, program will calculate normalized radial distributions of inert species for input to radiation code. |

| Column | Fortran Name | CARD 5 (continued) |
|---|---|---|
| 51-60 (E10.3) | CNZINT | mole fraction of $N_2$ at jet exit (only needed if CARBON = 1.0). If using this option, set mole fraction of $N_2$ in free stream, $X_{N_{2,e}}$ = .78973 |
| 61-70 (E10.3) | CVISC | multiplies values of turbulent viscosity at initial station (default, CVISC = 1.0) |

| Column | Fortran Name | CARD 6† |
|---|---|---|
| 1-10 (E10.3) | P | pressure (atm) for constant pressure mixing solution |
| 11-20 (E10.3) | U(1) | jet velocity (ft/sec) |
| 21-30 (E10.3) | U(MPSI) | external flow velocity (ft/sec) |
| 31-40 (E10.3) | T(1) | Jet exhaust temperature (°K) |
| 41-50 (E10.3) | T(MPSI) | external stream temperature (°K) |

| Column | Fortran Name | CARD 7 (must always input this card even if none of the parameters are used) |
|---|---|---|
| 1-10 (E10.3) | FFF | ratio of $\ell/\delta$ in Prandtl Mixing Length Model in nearfield shear layer region; use FFF = .065; must also be input for $k\varepsilon 2$ initialization procedure |
| 11-20 (E10.3) | GGG | ratio of $\ell/\delta$ in Mixing Length Model in fully developed region; use GGG = .08 |

†In overlaid procedure (IPRESS = 2) these values are redundant.

| Column | Fortran Name | CARD 7 (continued) |
|---|---|---|
| 21-30 (E10.3) | PSID | input PSID = 1.0 if "effective" plume boundary is to be calculated. Can only be used if IPRESS = 2; PSID must be set = 0 if IPRESS = 0 |
| 31-40 (E10.3) | DELJ | jet side boundary layer displacement thickness at nozzle exit plane (ft) |
| 41-50 (E10.3) | DELE | external boundary layer displacement thickness at nozzle exit plane (ft) |
| 51-60 (E10.3) | USTJ | jet side frictional velocity ratio (default value of 1/30 built in) |
| 61-70 (E10.3) | USTE | external frictional velocity ratio (default value of 1/30 built in) |
| 71-80 (E10.3) | RBUOY | bouyancy indicator; set RBUOY = 1.0 to include buoyancy term in momentum equation. |

*** Cards 8 and 9 are required only if IDELP < 0 (i.e., they are not required for a user specified initial profile)

| Column | Fortran Name | CARD 8 |
|---|---|---|
| 1-10 (E10.3) | ALPHA(1,1) | mole fraction of first jet exhaust species |
| 11-20 (E10.3) | ALPHA(2,1) | 2nd species, etc. Total of eight species per card |

| Column | Fortran Name | CARD 9 |
|---|---|---|
| 1-10 (E10.3) | ALPHA(1,MPSI) | mole fraction of first external stream species |
| 11-20 (E10.3) | ALPHA(2,MPSI) | 2nd species, etc. |

*** Cards 10-14 are required only if IDELP = 1 (i.e., for user specified initial profiles)

| Column | Fortran Name | CARD 10 |
|---|---|---|
| 1-10 (E10.3( | RIN(1) | nondimensional radial location (r/RJ) of first grid point out of MPSI user specified points. This point can be the lower edge of a shear layer. Do not input RIN(1) = 0 for axis, start with RIN(1) = .01 |
| 11-20 (E10.3) | RIN(2) | radial location of 2nd grid point, etc. |
| | | continue with a total of eight values per card |

| Column | Fortran Name | CARD 11 |
|---|---|---|
| 1-10 (E10.3) | T(1) | temperature of first grid point (°K) |
| 11-20 | T(2) | temperature at 2nd grid point (°K), etc. eight values per card |

| Column | Fortran Name | CARD 12 |
|---|---|---|
| 1-10 (E10.3) | U(1) | velocity at first grid point (ft/sec) |
| 11-20 (E10.3) | U(2) | velocity at 2nd grid point (ft/sec), etc., eight values per card |

*** Card 13 is required only when IVIS = -2 (i.e., when the TKE option is selected with a known initial turbulent kinetic energy profile)

| Column | Fortran Name | CARD 13 |
|---|---|---|
| 1-10 (E10.3) | XK(1) | turbulent kinetic energy at first grid point ($ft^2/sec^2$) |
| 11-20 (E10.3) | XK(2) | turbulent kinetic energy at 2nd grid point ($ft^2/sec^2$), etc., eight values per card |

| Column | Fortran Name | CARD 14.1 |
|---|---|---|
| 1-10 (E10.3) | ALPHA(1,1) | mole fraction of 1st species at 1st point |

| Column | Fortran Name | CARD 14.1 (continued) |
|---|---|---|
| 11-20 (E10.3) | ALPHA(2,1) | mole fraction of 2nd species at 1st point; continue to NS species, eight per card |

| Column | Fortran Name | CARD 14.2 |
|---|---|---|
| 1-10 (E.10.3) | ALPHA(1,2) | mole fraction of 1st species at 2nd point, etc.<br><br>continue to Card 14.MPSI in a similar manner |

*** The next group of cards contain the thermodynamic data. The order of the species must be consistent with that on Cards 9 or 14. For each species, the first card contains its name, molecular weight and heat of formation; the second and subsequent cards contain the temperature, gibbs free energy and static enthalpy, input exactly as presented in the JANNAF tables.

| Column | Fortran Name | CARD 15.1.1 |
|---|---|---|
| 1-4 (A4) | AID(1) | name of 1st species ($H_2O$, $CO_2$, etc.) |
| 7-16 (E10.3) | WTMOLE(1) | molecular weight of 1st species |
| 17-26 (E10.3) | HF(1) | heat of formation ($\Delta H_f^{298}$ - kcal/mole) |

| Column | Fortran Name | CARD 15.1.2 |
|---|---|---|
| 1-10 (F10.4) | TTB(1) | temperature of 1st species at 1st data point (°K) |
| 11-20 (F10.4) | CPTB(1) | $C_p$ of 1st species at 1st point, (cal/mole-°K) |
| 21-30 (F10.4) | GTB(1) | Gibbs free energy of 1st species at 1st point $-(F°-H°_{298})/T$, (cal/mole-°K) |

| Column | Fortran Name | CARD 15.1.2 (continued) |
|---|---|---|
| 31-40 (F10.4) | HTB(1) | static enthalpy of 1st species at 1st point, $(H°-H°_{298})$, (kcal/mole) |
| 41-50 (F10.4) | TTB(2) | temperature of 1st species at 2nd point |
| 51-60 (F10.4) | CPTB(2) | same as above at 2nd point |
| 61-70 (F10.4) | GTB(2) | |
| 71-80 (F10.4) | HTB(2) | |

| Column | Fortran Name | CARD 15.1.3 |
|---|---|---|
| 1-10 (F10.4) | TTB(3) | temperature of 1st species at 3rd data point, etc. This is continued until the data at all NT points (input on Card 3) is specified for the 1st species |

| Column | Fortran Name | CARD 15.2.1 |
|---|---|---|
| 1-4 (A4) | AID(2) | name of second species, etc. Repeat the sequence of cards 15.1.1---15.1.(NT/2) for each of the NS species |

*** The next group of cards contain the chemical reaction mechanism, the reaction type indicator and associated rate coefficient data. The order here is arbitrary.

| Column | Fortran Name | CARD 16.1 - First Reaction |
|---|---|---|
| 1-6 (A6) | ZID(1) | species A |
| 7 | + sign | |

| Column | Fortran Name | CARD 16.1 (continued) |
|---|---|---|
| 8-13 (A6) | ZID(2) | species B (or M) |
| 14 | + sign | (if needed) |
| 15-20 (A6) | ZID(3) | (Blank or M) |
| 21 | = sign | |
| 22-27 (A6) | ZID(3 or 4) | species C |
| 28 | + sign | (if needed) |
| 29-34 (A6) | ZID(4 or 5) | species D (or M) |
| 35 | + sign | (if needed) |
| 36-41 (A6) | Blank or ZID(5) | species E (or M) |
| 42-48 | leave blank | |
| 49-50 (I2) | IRR(1) | reaction type, 1 to 10 (see NASA CR-3075) |
| 51 (I1) | IRT(1) | rate coefficient type, 1 to 8 (see NASA CR-3075) |
| 52-59 (E8.2) | RC(1,1) | pre-exponential factor, A, (cm-molecule-sec units); note that $k_f = AT^{-N} \exp(B/RT)$ |
| 60-63 (F4.1) | RC(1,2) | temperature exponent, N |
| 64-72 (F9.1) | RC(1,3) | activation energy, B (cal/mole) |

CARD 16.2 - Second Reaction

repeat procedure of Card 16.1 for each reaction

*** The next group of cards comprise the inviscid flowfield data and are required only if IPRESS = 2

| Column | Fortran Name | CARD 17.1.1 |
|---|---|---|
| 1-2 (I2) | LMAP | number of data points for 1st jet station (maximum of 25) |
| 6-15 (E10.3) | XJET(1) | axial location of 1st jet data station (ft) |

| Column | Fortran Name | CARD 17.1.2 |
|---|---|---|
| 1-10 (E10.3) | VJET(1,1,1) | radial location (ft) of 1st point at 1st station (must be axis point) |
| 11-20 (E10.3) | VJET(1,2,1) | radial location (ft) of 2nd point at 1st station, etc. |

| Column | Fortran Name | CARD 17.1.3 |
|---|---|---|
| 1-10 (E10.3) | VJET(2,1,1) | pressure (atm) at 1st point |
| 11-20 (E10.3) | VJET(2,2,1) | pressure (atm) at 2nd point, etc. |

| Column | Fortran Name | CARD 17.1.4 |
|---|---|---|
| 1-10 (E10.3) | VJET(3,1,1) | temperature (°K) at 1st point |
| 11-20 (E10.3) | VJET(3,2,1) | temperature (°K) at 2nd point, etc. |

CARD 17.1.5

| Column | Fortran Name | |
|---|---|---|
| 1-10 (E10.3) | VJET(4,1,1) | velocity (ft/sec) at 1st point |
| 11-20 (E10.3) | VJET(4,2,1) | velocity (ft/sec) at 2nd point, etc. |

CARD 17.2.1

| Column | Fortran Name | |
|---|---|---|
| 1-2 (I2) | LMAP | number of data points for 2nd jet station |
| 6-15 (E10.3) | XJET(2) | axial location of 2nd jet station (ft) |

Continue supplying jet data in this sequence for all IMAXJ stations.

CARD 18.1.1

| Column | Fortran Name | |
|---|---|---|
| 1-2 (I2) | LMAP | number of data points for 1st external flow station (maximum of 25) |
| 6-15 (E10.3) | XEXT(1) | axial location of 1st external stream data station (ft) |

CARD 18.1.2

| Column | Fortran Name | |
|---|---|---|
| 1-10 (E10.3) | VEXT(1,1,1) | radial location (ft) of 1st point at 1st station (must be at inviscid plume interface) |
| 11-20 (E10.3) | VEXT(1,2,1) | radial location (ft) of 2nd point, etc. |

CARD 18.1.3

| Column | Fortran Name | |
|---|---|---|
| 1-10 (E10.3) | VEXT(2,1,1) | pressure (atm) at 1st point, etc. |

| Column | Fortran Name | CARD 18.1.4 |
|---|---|---|
| 1-10 (E10.3) | VEXT(3,1,1) | temperature (°K) at 1st point, etc. |

| Column | Fortran Name | CARD 18.1.5 |
|---|---|---|
| 1-10 (E10.3) | VEXT(4,1,1) | velocity (ft/sec) at 1st point, etc. |

... Continue supplying external flow data in this sequence for all IMAXE stations.

# 5. DEFINITIONS OF KEY FORTRAN VARIABLES AND PROGRAM WORKING UNITS

| | |
|---|---|
| ALPHA(J,I)[†] | mole fraction of species J (input at grid point I); redefined in BOATS1 as ALPHA(J,I) = ALPHA(J,I)/WTVR where WTVR = mixture molecular weight |
| CPBAR | specific heat of mixture, $ft^2/sec^2/°K$ |
| HSTAT | static enthalpy of mixture, $ft^2/sec^2$ |
| P | pressure, $lb_f/ft^2$ (input in atm) |
| PSI | mass flow (radial) coordinate, $(slug/sec)^{\frac{1}{2}}$ |
| RHO | density, $gm/cm^3$ |
| SIGMA | turbulent Prandtl number |
| T[†] | temperature, K° |
| U[†] | velocity, ft/sec |
| WDOT(J,I) | chemical reaction rate of species J at grid point I, $mole/cm^3$-sec |
| WTMIX | reciprocal of mixture molecular weight |
| X | axial distance, ft. |
| XE[†] | turbulent dissipation, $(ft/sec)^2/sec$ |
| XK[†] | turbulent kinetic energy, $ft^2/sec^2$ |

[†]Note that RALPHA, RT, RU, RXE, RXK are values of these dependent variables at the end of an integration step.

| | |
|---|---|
| XLE | turbulent Lewis number |
| XMU | turbulent viscosity, slug/ft-sec |
| Y | radial distance from axis, ft |

# 6. TEST CASE

Input and output for a sample case are given in this section. The case is a nearly perfectly expanded cold air jet, with a total to exit static pressure ratio of 2.0, and is one of the cases analyzed in NASA CR-3075.

```
CARD NO.
    1    1                    10.0        10.0
    2          TEST CASE 1 - WITH INVISCID FLOW MAPS
    3       49    49     2     0    22    -1     2    -1     4     6     8     6
    4            .01       .125       3.00          .500       1.75        .50         .2         .05
    5           1.0        1.0        5.0
    6           1.0     1120.0      396.0        238.0       296.0
    7           .065       .080       1.0          .00167       .03         .033       .033
    8           .21        .79
    9           .21        .79
15.1.1  02          31.9988          0.0
            100.      6.958      55.205      -1.381       200.      6.961     49.643    -0.685
            400.      7.196      49.282       0.724       600.      7.670     50.414     2.210
            800.      8.063      51.629       3.786      1000.      8.336     52.765     5.427
           1200.      8.527      53.801       7.114      1400.      8.674     54.744     8.835
           1600.      8.800      55.608      10.583      1800.      8.916     56.401    12.354
           2000.      9.027      57.136      14.149      2200.      9.139     57.819    15.966
           2400.      9.248      58.457      17.804      2600.      9.354     59.057    19.664
           2800.      9.455      59.622      21.545      3000.      9.551     60.157    23.446
           3200.      9.640      60.665      25.365      3400.      9.723     61.149    27.302
           3600.      9.799      61.611      29.254      3800.      9.869     62.053    31.221
15.1.12    4000.      9.932      62.476      33.201      4200.      9.988     62.883    35.193
15.2.1  N2          28.00
            100.      6.956      51.957      -1.379       200.      6.957     46.407    -0.663
            400.      6.990      46.043       0.710       600.      7.196     47.143     2.125
            800.      7.512      48.303       3.596      1000.      7.815     49.378     5.129
           1200.      8.061      50.357       6.718      1400.      8.252     51.248     8.350
           1600.      8.398      52.065      10.015      1800.      8.512     52.816    11.707
           2000.      8.601      53.513      13.418      2200.      8.672     54.160    15.146
           2400.      8.731      54.766      16.886      2600.      8.779     55.335    18.638
           2800.      8.820      55.870      20.398      3000.      8.855     56.376    22.165
           3200.      8.886      56.856      23.939      3400.      8.914     57.312    25.719
           3600.      8.939      57.747      27.505      3800.      8.962     58.162    29.295
15.2.12    4000.      8.983      58.559      31.089      4200.      9.002     58.940    32.888
17.1.1      6    .00625
           0.          .02502     .05004     .07506     .10008     .1251
           .946939     .946939    .946939    .946939    .946939    .887282
           242.61      242.61     242.61     242.61     242.61     238.17
           1075.64     1075.64    1075.64    1075.64    1075.64    1119.19
17.2.1      6    .073874
           0.          .025093    .050185    .075278    .10037     .125463
           .75471      .844651    .869856    .884253    .895044    .90338
           227.35      235.11     236.75     237.89     238.74     239.35
           1219.36     1148.38    1132.89    1122.08    1113.81    1107.76
17.3.1      6    .159223
           0.          .025038    .050075    .075113    .10015     .125188
           1.022694    .990525    .940687    .919669    .904515    .897698
           247.89      245.5      242.23     240.6      239.44     238.92
           1021.36     1046.03    1079.45    1095.61    1107.      1111.92
17.4.1      6    3.5
```

```
                0.          .025        .050        .075        .100        .125150
                .8878       .8878       .8878       .8878       .8878       .8878
                250.69      250.69      250.69      250.69      250.69      250.69
                1097.97     1097.97     1097.97     1097.97     1097.97     1097.97
18.1.1           6   0.
                .127494     .155694     .204734     .257329     .313834     .374644
                .908843     .908843     .901829     .897709     .895029     .893159
                298.26      298.26      297.6       297.21      296.96      296.78
                396.48      396.48      414.77      425.28      432.        436.63
18.2.1           6   .069445
                .125803     .154033     .203072     .255668     .312172     .372983
                .903165     .903165     .899963     .897216     .895038     .893342
                297.73      297.73      297.42      297.16      296.96      296.8
                412.95      412.95      420.52      427.07      432.31      436.38
18.3.1           6   .147959
                .122231     .150431     .19947      .252066     .30857      .369381
                .897961     .897961     .897026     .895635     .89424      .892993
                297.23      297.23      297.1       297.01      296.88      296.76
                425.18      425.18      427.64      431.01      434.34      437.3
18.4.1           6   .234375
                .12025      .14945      .19749      .250086     .30659      .3674
                .896574     .896574     .895262     .89423      .893274     .892394
                297.1       297.1       296.98      296.88      296.79      296.71
                428.95      428.95      431.99      434.47      436.71      438.78
18.5.1           6   .333334
                .119218     .147418     .196458     .249054     .305558     .366368
                .893570     .89357      .893209     .892723     .892185     .891634
                296.82      296.82      296.78      296.74      296.69      296.63
                436.07      436.07      436.91      438.05      439.31      440.59
18.6.1           6   .446429
                .118346     .146546     .195585     .248181     .304686     .365496
                .892102     .892102     .891833     .891541     .891224     .890886
                296.68      296.68      296.65      296.63      296.6       296.56
                439.52      439.52      440.15      440.83      441.57      442.35
18.7.1           6   .576923
                .11791      .14611      .19515      .247745     .30425      .36506
                .89089      .89089      .890747     .890587     .890408     .89021
                296.56      296.56      296.55      296.53      296.52      296.5
                442.35      442.35      442.69      443.06      443.47      443.93
18.8.1           12  3.5
                .125150     .148443     .197482     .250078     .306582     .367393     .432960     .503799
                .580494     .663719     .754247     .852977
                .887940     .887940     .887940     .887939     .887939     .887938     .887938     .887937
                .887935     .887934     .887932     .887930
                296.28      296.28      296.28      296.28      296.28      296.28      296.28      296.28
                296.28      296.28      296.28      296.28
                449.17      449.17      449.17      449.17      449.17      449.17      449.18      449.18
                449.18      449.18      449.19      449.19
```

## 6.2 Sample Output

Some terms that appear on the output and are not defined elsewhere, or whose definition is not obvious, are defined below.

PSIBAR — Nondimensional mass flow parameter.

MASS FLOW PARAMETER — for JET, Inviscid map, = PSI (JET)
for EXT, Inviscid map, = PSI (EXT).

ENTH-TKE — If kε2 turbulence option used, this column prints the turbulent kinetic energy, XK, in $ft^2/sec^2$ - for all other options it prints static enthalpy in cal/gm.

PR-XE — If kε2 turbulence option is used, this column prints turbulent dissipation, XE, in $(ft/sec)^2/sec$ - for all other options it prints static pressure, in atm.

XBAR — Axial distance/jet radius.

PSID — Value of PSI at dividing streamline.

PSI(X) — Value of PSI at edge of shear layer.

Y(MPSI) — Value of Y at edge of shear layer.

SLOPE — dY/dX at edge of shear layer.

V/U — Ratio of normal to axial velocity at edge of shear layer.

DEL*(X) — Local value of $\delta^*$

DEL*(X-DX) — $\delta^*$ at previous station.

RDIV — Radius of viscous dividing streamline/jet radius.

REFF — Radius of effective body/jet radius.

JET, INVISCID MAP

STATION NUMBER 1 AXIAL LOCATION = .62500E-02 MASS FLOW PARAMETER = .21156E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | 0. | .94694E+00 | .24261E+03 | .10756E+04 | 0. |
| 2 | .25004E-01 | .94694E+00 | .24261E+03 | .10756E+04 | .20000E+00 |
| 3 | .50009E-01 | .94694E+00 | .24261E+03 | .10756E+04 | .40000E+00 |
| 4 | .75013E-01 | .94694E+00 | .24261E+03 | .10756E+04 | .60000E+00 |
| 5 | .10002E+00 | .94694E+00 | .24261E+03 | .10756E+04 | .80000E+00 |
| 6 | .12510E+00 | .88728E+00 | .23817E+03 | .11192E+04 | .10000E+01 |

STATION NUMBER 2 AXIAL LOCATION = .73874E-01 MASS FLOW PARAMETER = .21156E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | 0. | .75471E+00 | .22735E+03 | .12194E+04 | 0. |
| 2 | .25310E-01 | .84883E+00 | .23512E+03 | .11482E+04 | .20000E+00 |
| 3 | .50359E-01 | .86996E+00 | .23676E+03 | .11328E+04 | .40000E+00 |
| 4 | .75402E-01 | .88431E+00 | .23789E+03 | .11220E+04 | .60000E+00 |
| 5 | .10044E+00 | .89507E+00 | .23874E+03 | .11138E+04 | .80000E+00 |
| 6 | .12546E+00 | .90338E+00 | .23935E+03 | .11078E+04 | .10000E+01 |

STATION NUMBER 3 AXIAL LOCATION = .15922E+00 MASS FLOW PARAMETER = .21156E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | 0. | .10227E+01 | .24789E+03 | .10214E+04 | 0. |
| 2 | .24951E-01 | .99064E+00 | .24551E+03 | .10453E+04 | .20000E+00 |
| 3 | .49950E-01 | .94094E+00 | .24225E+03 | .10793E+04 | .40000E+00 |
| 4 | .75019E-01 | .91975E+00 | .24061E+03 | .10955E+04 | .60000E+00 |
| 5 | .10010E+00 | .90455E+00 | .23944E+03 | .11070E+04 | .80000E+00 |
| 6 | .12519E+00 | .89770E+00 | .23892E+03 | .11119E+04 | .10000E+01 |

STATION NUMBER 4 AXIAL LOCATION = .35000E+01 MASS FLOW PARAMETER = .21156E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | 0. | .88780E+00 | .25069E+03 | .10980E+04 | 0. |
| 2 | .25030E-01 | .88780E+00 | .25069E+03 | .10980E+04 | .20000E+00 |
| 3 | .50030E-01 | .88780E+00 | .25069E+03 | .10980E+04 | .40000E+00 |
| 4 | .75090E-01 | .88780E+00 | .25069E+03 | .10980E+04 | .60000E+00 |
| 5 | .10012E+00 | .88780E+00 | .25069E+03 | .10980E+04 | .80000E+00 |
| 6 | .12515E+00 | .88780E+00 | .25069E+03 | .10980E+04 | .10000E+01 |

EXIT INVISCID MAP

STATION NUMBER 1 AXIAL LOCATION = 0. MASS FLOW PARAMETER = .39125E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .12749E+00 | .90884E+00 | .29826E+03 | .39648E+03 | 0. |
| 2 | .18910E+00 | .90406E+00 | .29761E+03 | .40894E+03 | .20000E+00 |
| 3 | .24082E+00 | .89900E+00 | .29733E+03 | .42198E+03 | .40000E+00 |
| 4 | .28758E+00 | .89627E+00 | .29708E+03 | .42888E+03 | .60000E+00 |
| 5 | .33185E+00 | .89448E+00 | .29691E+03 | .43337E+03 | .80000E+00 |
| 6 | .37464E+00 | .89316E+00 | .29678E+03 | .43663E+03 | .10000E+01 |

STATION NUMBER 2 AXIAL LOCATION = .59445E-01 MASS FLOW PARAMETER = .39142E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .12580E+00 | .90317E+00 | .29773E+03 | .41295E+03 | 0. |
| 2 | .18649E+00 | .90105E+00 | .29752E+03 | .41796E+03 | .20000E+00 |
| 3 | .23827E+00 | .89812E+00 | .29725E+03 | .42490E+03 | .40000E+00 |
| 4 | .28533E+00 | .89607E+00 | .29705E+03 | .42982E+03 | .60000E+00 |
| 5 | .32991E+00 | .89454E+00 | .29691E+03 | .43350E+03 | .80000E+00 |
| 6 | .37298E+00 | .89334E+00 | .29680E+03 | .43638E+03 | .10000E+01 |

STATION NUMBER 3 AXIAL LOCATION = .14706E+00 MASS FLOW PARAMETER = .39066E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .12223E+00 | .89796E+00 | .29723E+03 | .42518E+03 | 0. |
| 2 | .18271E+00 | .89735E+00 | .29718E+03 | .42680E+03 | .20000E+00 |
| 3 | .23446E+00 | .89610E+00 | .29706E+03 | .42988E+03 | .40000E+00 |
| 4 | .28158E+00 | .89491E+00 | .29694E+03 | .43275E+03 | .60000E+00 |
| 5 | .32623E+00 | .89388E+00 | .29685E+03 | .43520E+03 | .80000E+00 |
| 6 | .36938E+00 | .89299E+00 | .29676E+03 | .43730E+03 | .10000E+01 |

STATION NUMBER 4 AXIAL LOCATION = .23438E+00 MASS FLOW PARAMETER = .39036E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .12025E+00 | .89657E+00 | .29710E+03 | .42895E+03 | 0. |
| 2 | .18088E+00 | .89572E+00 | .29702E+03 | .43096E+03 | .20000E+00 |
| 3 | .23258E+00 | .89458E+00 | .29691E+03 | .43364E+03 | .40000E+00 |
| 4 | .27964E+00 | .89373E+00 | .29683E+03 | .43564E+03 | .60000E+00 |
| 5 | .32426E+00 | .89302E+00 | .29677E+03 | .43731E+03 | .80000E+00 |
| 6 | .36740E+00 | .89239E+00 | .29671E+03 | .43878E+03 | .10000E+01 |

STATION NUMBER 5 AXIAL LOCATION = .33333E+00 MASS FLOW PARAMETER = .39077E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .11922E+00 | .89357E+00 | .29682E+03 | .43607E+03 | 0. |
| 2 | .17966E+00 | .89333E+00 | .29679E+03 | .43662E+03 | .20000E+00 |
| 3 | .23133E+00 | .89289E+00 | .29675E+03 | .43767E+03 | .40000E+00 |
| 4 | .27844E+00 | .89244E+00 | .29671E+03 | .43871E+03 | .60000E+00 |
| 5 | .32314E+00 | .89203E+00 | .29667E+03 | .43968E+03 | .80000E+00 |
| 6 | .36637E+00 | .89163E+00 | .29663E+03 | .44059E+03 | .10000E+01 |

STATION NUMBER 6 AXIAL LOCATION = .44643E+00 MASS FLOW PARAMETER = .39097E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .11835E+00 | .89210E+00 | .29668E+03 | .43952E+03 | 0. |
| 2 | .17881E+00 | .89193E+00 | .29666E+03 | .43993E+03 | .20000E+00 |
| 3 | .23045E+00 | .89164E+00 | .29664E+03 | .44060E+03 | .40000E+00 |
| 4 | .27755E+00 | .89138E+00 | .29661E+03 | .44121E+03 | .60000E+00 |
| 5 | .32225E+00 | .89113E+00 | .29659E+03 | .44180E+03 | .80000E+00 |
| 6 | .36550E+00 | .89089E+00 | .29656E+03 | .44235E+03 | .10000E+01 |

STATION NUMBER 7 AXIAL LOCATION = .57692E+00 MASS FLOW PARAMETER = .39129E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .11791E+00 | .89089E+00 | .29656E+03 | .44235E+03 | 0. |
| 2 | .17835E+00 | .89080E+00 | .29655E+03 | .44257E+03 | .20000E+00 |
| 3 | .22997E+00 | .89064E+00 | .29654E+03 | .44293E+03 | .40000E+00 |
| 4 | .27707E+00 | .89049E+00 | .29652E+03 | .44327E+03 | .60000E+00 |
| 5 | .32179E+00 | .89035E+00 | .29651E+03 | .44360E+03 | .80000E+00 |
| 6 | .36506E+00 | .89021E+00 | .29650E+03 | .44393E+03 | .10000E+01 |

STATION NUMBER 8 AXIAL LOCATION = .35000E+01 MASS FLOW PARAMETER = .83569E+00

| PT | Y | P | T | U | PSIBAR |
|---|---|---|---|---|---|
| 1 | .12515E+00 | .88794E+00 | .29628E+03 | .44917E+03 | 0. |
| 2 | .30011E+00 | .88794E+00 | .29628E+03 | .44917E+03 | .20000E+00 |
| 3 | .44554E+00 | .88794E+00 | .29628E+03 | .44918E+03 | .40000E+00 |
| 4 | .58392E+00 | .88793E+00 | .29628E+03 | .44918E+03 | .60000E+00 |
| 5 | .71916E+00 | .88793E+00 | .29628E+03 | .44919E+03 | .80000E+00 |
| 6 | .85298E+00 | .88793E+00 | .29628E+03 | .44919E+03 | .10000E+01 |

JET SIDE BOUNDARY LAYER PROFILE FROM I = 1 TO 3

| ENTHALPY | CP | MOL WT | GAS CONST | GAMMA | SOUND SPEED | MACH |
|---|---|---|---|---|---|---|
| -.88632E+04 | .10893E+05 | .28840E+02 | .31040E+04 | .13985E+01 | .10169E+04 | .10999E+01 |

| RIN | U | T | TERM | UX | TX | DUMA | DUMB |
|---|---|---|---|---|---|---|---|
| .10000E+01 | .11186E+04 | .23824E+03 | 0. | .11186E+04 | .23824E+03 | 0. | 0. |
| .50000E+00 | .10037E+04 | .24943E+03 | .71495E-01 | .11186E+04 | .23824E+03 | .17874E-01 | .35748E-01 |
| .10000E-02 | 0. | .29567E+03 | .57150E+00 | .11186E+04 | .23824E+03 | .35961E-01 | .32092E+00 |

PHYSICAL Y DISTRIBUTION

.11993E+00
.12252E+00
.12511E+00

EXTERNAL BOUNDARY LAYER PROFILE FROM I = 4 TO 49

| ENTHALPY | CP | MOL WT | GAS CONST | GAMMA | SOUND SPEED | MACH |
|---|---|---|---|---|---|---|
| -.88632E+04 | .10927E+05 | .28840E+02 | .31040E+04 | .13968E+01 | .11349E+04 | .37802E+00 |

| RIN | U | T | TERM | UX | TX | DUMA | DUMB |
|---|---|---|---|---|---|---|---|
| .10000E-02 | 0. | .30549E+03 | .57150E+00 | .42901E+03 | .29707E+03 | 0. | 0. |
| .22222E-01 | .25525E+03 | .30251E+03 | .70786E+00 | .42901E+03 | .29707E+03 | .10864E-03 | .15022E-01 |
| .44444E-01 | .27993E+03 | .30191E+03 | .38684E+00 | .42901E+03 | .29707E+03 | .38805E-03 | .23619E-01 |
| .66667E-01 | .29451E+03 | .30153E+03 | .34080E+00 | .42901E+03 | .29707E+03 | .80455E-03 | .31192E-01 |
| .88889E-01 | .30502E+03 | .30124E+03 | .31123E+00 | .42901E+03 | .29707E+03 | .13394E-02 | .38108E-01 |
| .11111E+00 | .31334E+03 | .30100E+03 | .28898E+00 | .42901E+03 | .29707E+03 | .19792E-02 | .44530E-01 |
| .13333E+00 | .32031E+03 | .30080E+03 | .27088E+00 | .42901E+03 | .29707E+03 | .27129E-02 | .50550E-01 |
| .15556E+00 | .32636E+03 | .30062E+03 | .25543E+00 | .42901E+03 | .29707E+03 | .35310E-02 | .56226E-01 |
| .17778E+00 | .33177E+03 | .30046E+03 | .24181E+00 | .42901E+03 | .29707E+03 | .44250E-02 | .61600E-01 |
| .20000E+00 | .33670E+03 | .30031E+03 | .22949E+00 | .42901E+03 | .29707E+03 | .53869E-02 | .66699E-01 |
| .22222E+00 | .34127E+03 | .30017E+03 | .21816E+00 | .42901E+03 | .29707E+03 | .64090E-02 | .71548E-01 |
| .24444E+00 | .34555E+03 | .30003E+03 | .20759E+00 | .42901E+03 | .29707E+03 | .74841E-02 | .76161E-01 |
| .26667E+00 | .34962E+03 | .29990E+03 | .19761E+00 | .42901E+03 | .29707E+03 | .86051E-02 | .80552E-01 |
| .28889E+00 | .35349E+03 | .29978E+03 | .18810E+00 | .42901E+03 | .29707E+03 | .97651E-02 | .84732E-01 |
| .31111E+00 | .35722E+03 | .29966E+03 | .17898E+00 | .42901E+03 | .29707E+03 | .10957E-01 | .88709E-01 |
| .33333E+00 | .36082E+03 | .29954E+03 | .17019E+00 | .42901E+03 | .29707E+03 | .12175E-01 | .92491E-01 |
| .35556E+00 | .36431E+03 | .29942E+03 | .16167E+00 | .42901E+03 | .29707E+03 | .13411E-01 | .96084E-01 |
| .37778E+00 | .36770E+03 | .29931E+03 | .15339E+00 | .42901E+03 | .29707E+03 | .14660E-01 | .99493E-01 |
| .40000E+00 | .37100E+03 | .29920E+03 | .14533E+00 | .42901E+03 | .29707E+03 | .15915E-01 | .10272E+00 |
| .42222E+00 | .37423E+03 | .29909E+03 | .13745E+00 | .42901E+03 | .29707E+03 | .17170E-01 | .10578E+00 |
| .44444E+00 | .37738E+03 | .29898E+03 | .12976E+00 | .42901E+03 | .29707E+03 | .18418E-01 | .10866E+00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| .46667E+00 | .38045E+03 | .29887E+03 | .12223E+00 | .42901E+03 | .29707E+03 | .19655E-01 | .11138E+00 |
| .48889E+00 | .38346E+03 | .29877E+03 | .11487E+00 | .42901E+03 | .29707E+03 | .20874E-01 | .11393E+00 |
| .51111E+00 | .38640E+03 | .29866E+03 | .10768E+00 | .42901E+03 | .29707E+03 | .22069E-01 | .11632E+00 |
| .53333E+00 | .38926E+03 | .29856E+03 | .10064E+00 | .42901E+03 | .29707E+03 | .23236E-01 | .11856E+00 |
| .55556E+00 | .39206E+03 | .29846E+03 | .93768E-01 | .42901E+03 | .29707E+03 | .24370E-01 | .12064E+00 |
| .57778E+00 | .39478E+03 | .29836E+03 | .87065E-01 | .42901E+03 | .29707E+03 | .25465E-01 | .12258E+00 |
| .60000E+00 | .39743E+03 | .29827E+03 | .80537E-01 | .42901E+03 | .29707E+03 | .26519E-01 | .12437E+00 |
| .62222E+00 | .40000E+03 | .29817E+03 | .74190E-01 | .42901E+03 | .29707E+03 | .27525E-01 | .12602E+00 |
| .64444E+00 | .40249E+03 | .29808E+03 | .68030E-01 | .42901E+03 | .29707E+03 | .28482E-01 | .12753E+00 |
| .66667E+00 | .40489E+03 | .29799E+03 | .62065E-01 | .42901E+03 | .29707E+03 | .29386E-01 | .12891E+00 |
| .68889E+00 | .40721E+03 | .29791E+03 | .56304E-01 | .42901E+03 | .29707E+03 | .30233E-01 | .13016E+00 |
| .71111E+00 | .40943E+03 | .29782E+03 | .50754E-01 | .42901E+03 | .29707E+03 | .31022E-01 | .13129E+00 |
| .73333E+00 | .41157E+03 | .29774E+03 | .45423E-01 | .42901E+03 | .29707E+03 | .31750E-01 | .13230E+00 |
| .75556E+00 | .41360E+03 | .29767E+03 | .40320E-01 | .42901E+03 | .29707E+03 | .32416E-01 | .13319E+00 |
| .77778E+00 | .41554E+03 | .29759E+03 | .35452E-01 | .42901E+03 | .29707E+03 | .33020E-01 | .13398E+00 |
| .80000E+00 | .41738E+03 | .29752E+03 | .30827E-01 | .42901E+03 | .29707E+03 | .33560E-01 | .13466E+00 |
| .82222E+00 | .41911E+03 | .29746E+03 | .26451E-01 | .42901E+03 | .29707E+03 | .34036E-01 | .13525E+00 |
| .84444E+00 | .42074E+03 | .29739E+03 | .22332E-01 | .42901E+03 | .29707E+03 | .34449E-01 | .13575E+00 |
| .86667E+00 | .42225E+03 | .29734E+03 | .18474E-01 | .42901E+03 | .29707E+03 | .34800E-01 | .13616E+00 |
| .88889E+00 | .42366E+03 | .29728E+03 | .14882E-01 | .42901E+03 | .29707E+03 | .35090E-01 | .13649E+00 |
| .91111E+00 | .42496E+03 | .29723E+03 | .11562E-01 | .42901E+03 | .29707E+03 | .35321E-01 | .13675E+00 |
| .93333E+00 | .42614E+03 | .29719E+03 | .85150E-02 | .42901E+03 | .29707E+03 | .35495E-01 | .13694E+00 |
| .95556E+00 | .42721E+03 | .29714E+03 | .57447E-02 | .42901E+03 | .29707E+03 | .35615E-01 | .13706E+00 |
| .97778E+00 | .42816E+03 | .29711E+03 | .32521E-02 | .42901E+03 | .29707E+03 | .35685E-01 | .13714E+00 |
| .10000E+01 | .42901E+03 | .29707E+03 | .10377E-02 | .42901E+03 | .29707E+03 | .35707E-01 | .13716E+00 |

PHYSICAL Y DISTRIBUTION

.12530E+00
.12909E+00
.13306E+00
.13703E+00
.14099E+00
.14496E+00
.14893E+00
.15290E+00
.15687E+00
.16084E+00
.16481E+00
.16877E+00
.17274E+00
.17671E+00
.18068E+00
.18465E+00
.18862E+00
.19259E+00
.19656E+00
.20052E+00
.20449E+00

.20846E+00
.21243E+00
.21640E+00
.22037E+00
.22434E+00
.22830E+00
.23227E+00
.23624E+00
.24021E+00
.24418E+00
.24815E+00
.25212E+00
.25608E+00
.26005E+00
.26402E+00
.26799E+00
.27196E+00
.27593E+00
.27990E+00
.28386E+00
.28783E+00
.29180E+00
.29577E+00
.29974E+00
.30371E+00

AERONAUTICAL RESEARCH ASSOCIATES OF PRINCETON
AXISYMMETRIC MIXING WITH NON-EQUILIBRIUM CHEMISTRY

TEST CASE 1 - WITH INVISCID FLOW MAPS

INITIALIZATION OF BOAT RUN, RESTART FILE - , BOAT-SPECRA FILE - 78/09/20.

PRESSURE(INITIAL) = .8961563E+00 ATMOSPHERES

NOZZLE RADIUS= .1250000E+00 FEET BUOYANCY FACTOR = 0.

LEWIS NUMBER(CONSTANT)= .1000000E+01 PRANDTL NUMBER(CONSTANT)= .1000000E+01

X INITIAL(FEET)= .1000000E-01 X FINAL(FEET)= .3000000E+01

PRINT INCREMENT= .5000000E+00 MINIMUM STEP SIZE= .1000000E-09

KE2 TURBULENCE MODEL

| | JET | EDGE |
|---|---|---|
| TEMPERATURE(DEG. KELVIN) | .2382354E+03 | .2970733E+03 |
| VELOCITY (FEET/SECOND) | .1118556E+04 | .4290072E+03 |
| MOLE FRACTION O2 | .2100000E+00 | .2100000E+00 |
| MOLE FRACTION N2 | .7900000E+00 | .7900000E+00 |

| X/R | DELTA X FEET | PRESS(.TM) |
|---|---|---|
| .8000000E-01 | .9251131E-03 | .8961106E+00 |

| PT | Y/R | VELOCITY FEET/SEC | TEMPERATURE K | DENSITY GM/CC | MACH NO. | ENTH-TKE CAL/GM | VISCOSITY LB/FT/SEC | PSI | PR-KE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .9594 | .1114561E+04 | .2382351E+03 | .1327751E-02 | .1099921E+01 | 0. | 0. | .2027971E+00 | 0. |
| 2 | .9717 | .1048721E+04 | .2450391E+03 | .1286171E-02 | .1016911E+01 | .3246731E+05 | .4335961E-02 | .2052851E+00 | .1756521E+10 |
| 3 | .9892 | .5348981E+03 | .2708401E+03 | .1159381E-02 | .4971741E+00 | .1268121E+05 | .2442531E-02 | .2077731E+00 | .4287691E+09 |
| 4 | 1.0268 | .2711761E+03 | .3021241E+03 | .1035511E-02 | .2369531E+00 | .2585891E+03 | .3115391E-03 | .2102621E+00 | .1248541E+07 |
| 5 | 1.0820 | .2980461E+03 | .3014291E+03 | .1059881E-02 | .2607311E+00 | .4367371E+04 | .2697901E-01 | .2127501E+00 | .4205461E+07 |
| 6 | 1.1311 | .3122141E+03 | .3010341E+03 | .1059911E-02 | .2733031E+00 | .1753931E+04 | .1711311E-01 | .2152381E+00 | .1070291E+07 |
| 7 | 1.1769 | .3220491E+03 | .3007491E+03 | .1060561E-02 | .2820451E+00 | .1062841E+04 | .1337991E-01 | .2177261E+00 | .5048761E+06 |
| 8 | 1.2203 | .3294141E+03 | .3005171E+03 | .1061021E-02 | .2889561E+00 | .7764541E+03 | .1133921E-01 | .2202141E+00 | .3152521E+06 |
| 9 | 1.2617 | .3353721E+03 | .3003181E+03 | .1061371E-02 | .2947981E+00 | .6134951E+03 | .1013511E-01 | .2227021E+00 | .2214121E+06 |
| 10 | 1.3015 | .3402021E+03 | .3001421E+03 | .1061641E-02 | .2998351E+00 | .5080891E+03 | .9225491E-02 | .2251911E+00 | .1668761E+06 |
| 11 | 1.3400 | .3442771E+03 | .2999831E+03 | .1061841E-02 | .3043491E+00 | .4443301E+03 | .8623131E-02 | .2276791E+00 | .1364711E+06 |
| 12 | 1.3773 | .3517051E+03 | .2998351E+03 | .1062011E-02 | .3084831E+00 | .3998341E+03 | .8184761E-02 | .2301671E+00 | .1164941E+06 |
| 13 | 1.4135 | .3559941E+03 | .2996961E+03 | .1062151E-02 | .3123161E+00 | .3660081E+03 | .7833331E-02 | .2326551E+00 | .1020281E+06 |
| 14 | 1.4488 | .3600061E+03 | .2995641E+03 | .1062251E-02 | .3159051E+00 | .3394371E+03 | .7545751E-02 | .2351431E+00 | .9112171E+05 |
| 15 | 1.4832 | .3637871E+03 | .2994391E+03 | .1062341E-02 | .3192901E+00 | .3178981E+03 | .7302141E-02 | .2376311E+00 | .8258781E+05 |
| 16 | 1.5169 | .3673731E+03 | .2993191E+03 | .1062411E-02 | .3225011E+00 | .2999001E+03 | .7093071E-02 | .2401201E+00 | .7567421E+05 |
| 17 | 1.5498 | .3707881E+03 | .2992041E+03 | .1062461E-02 | .3255611E+00 | .2844141E+03 | .6907951E-02 | .2426081E+00 | .6988921E+05 |
| 18 | 1.5821 | .3740521E+03 | .2990931E+03 | .1062501E-02 | .3284871E+00 | .2707211E+03 | .6739741E-02 | .2450961E+00 | .6490321E+05 |
| 19 | 1.6138 | .3771801E+03 | .2989851E+03 | .1062521E-02 | .3312941E+00 | .2583091E+03 | .6583571E-02 | .2475841E+00 | .6049171E+05 |
| 20 | 1.6450 | .3801841E+03 | .2988811E+03 | .1062511E-02 | .3339901E+00 | .2468001E+03 | .6433141E-02 | .2500721E+00 | .5649391E+05 |
| 21 | 1.6756 | .3830731E+03 | .2987801E+03 | .1062481E-02 | .3365841E+00 | .2359481E+03 | .6291331E-02 | .2525611E+00 | .5280901E+05 |
| 22 | 1.7058 | .3858541E+03 | .2986821E+03 | .1062441E-02 | .3390831E+00 | .2255671E+03 | .6151701E-02 | .2550491E+00 | .4936241E+05 |
| 23 | 1.7355 | .3885331E+03 | .2985871E+03 | .1062391E-02 | .3414911E+00 | .2155261E+03 | .6012341E-02 | .2575371E+00 | .4610341E+05 |
| 24 | 1.7648 | .3911141E+03 | .2984951E+03 | .1062331E-02 | .3438131E+00 | .2057361E+03 | .5874441E-02 | .2600251E+00 | .4299821E+05 |
| 25 | 1.7937 | .3936021E+03 | .2984061E+03 | .1062261E-02 | .3460511E+00 | .1961391E+03 | .5735431E-02 | .2625131E+00 | .4002491E+05 |
| 26 | 1.8223 | .3960001E+03 | .2983191E+03 | .1062181E-02 | .3482101E+00 | .1866981E+03 | .5595291E-02 | .2650011E+00 | .3717021E+05 |
| 27 | 1.8505 | .3983111E+03 | .2982351E+03 | .1062091E-02 | .3502901E+00 | .1773951E+03 | .5453631E-02 | .2674901E+00 | .3442661E+05 |
| 28 | 1.8784 | .4005361E+03 | .2981541E+03 | .1061991E-02 | .3522951E+00 | .1682201E+03 | .5311241E-02 | .2699781E+00 | .3179081E+05 |
| 29 | 1.9060 | .4026781E+03 | .2980751E+03 | .1061881E-02 | .3542261E+00 | .1586161E+03 | .5155301E-02 | .2724661E+00 | .2910741E+05 |
| 30 | 1.9333 | .4047321E+03 | .2979991E+03 | .1061771E-02 | .3560781E+00 | .1483971E+03 | .4994501E-02 | .2749541E+00 | .2634041E+05 |
| 31 | 1.9603 | .4066971E+03 | .2979261E+03 | .1061641E-02 | .3578501E+00 | .1388291E+03 | .4822491E-02 | .2774421E+00 | .2383441E+05 |
| 32 | 1.9871 | .4085821E+03 | .2978561E+03 | .1061501E-02 | .3595511E+00 | .1301151E+03 | .4668091E-02 | .2799311E+00 | .2162601E+05 |
| 33 | 2.0137 | .4103901E+03 | .2977881E+03 | .1061351E-02 | .3611821E+00 | .1215961E+03 | .4512741E-02 | .2824191E+00 | .1953711E+05 |
| 34 | 2.0400 | .4121211E+03 | .2977231E+03 | .1061201E-02 | .3627451E+00 | .1133091E+03 | .4355141E-02 | .2849071E+00 | .1757441E+05 |
| 35 | 2.0661 | .4137771E+03 | .2976611E+03 | .1061031E-02 | .3642411E+00 | .1044881E+03 | .4182431E-02 | .2873951E+00 | .1556271E+05 |
| 36 | 2.0920 | .4153491E+03 | .2976011E+03 | .1061301E-02 | .3656601E+00 | .9522951E+02 | .3992821E-02 | .2898831E+00 | .1354071E+05 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 37 | 2.1177 | .416835E+03 | .297544E+03 | .106129E-02 | .367004E+00 | .869890E+02 | .381611E-02 | .292371E+00 | .118217E+05 |
| 38 | 2.1432 | .418249E+03 | .297490E+03 | .106127E-02 | .368282E+00 | .796950E+02 | .365254E-02 | .294860E+00 | .103664E+05 |
| 39 | 2.1686 | .419593E+03 | .297439E+03 | .106124E-02 | .369497E+00 | .727003E+02 | .349947E-02 | .297348E+00 | .903209E+04 |
| 40 | 2.1938 | .420866E+03 | .297390E+03 | .106120E-02 | .370649E+00 | .661721E+02 | .333273E-02 | .299836E+00 | .766614E+04 |
| 41 | 2.2188 | .422059E+03 | .297344E+03 | .106115E-02 | .371724E+00 | .574941E+02 | .310199E-02 | .302324E+00 | .635211E+04 |
| 42 | 2.2437 | .423165E+03 | .297301E+03 | .106108E-02 | .372729E+00 | .510094E+02 | .292165E-02 | .304812E+00 | .530834E+04 |
| 43 | 2.2685 | .424209E+03 | .297261E+03 | .106101E-02 | .373673E+00 | .453822E+02 | .275561E-02 | .307301E+00 | .445464E+04 |
| 44 | 2.2931 | .425186E+03 | .297223E+03 | .106093E-02 | .374558E+00 | .399082E+02 | .258388E-02 | .309789E+00 | .367347E+04 |
| 45 | 2.3177 | .426094E+03 | .297187E+03 | .106084E-02 | .375380E+00 | .338740E+02 | .238234E-02 | .312277E+00 | .287266E+04 |
| 46 | 2.3421 | .426915E+03 | .297155E+03 | .106074E-02 | .376124E+00 | .285081E+02 | .219347E-02 | .314765E+00 | .221787E+04 |
| 47 | 2.3664 | .427674E+03 | .297126E+03 | .106063E-02 | .376811E+00 | .244083E+02 | .202917E-02 | .317253E+00 | .175709E+04 |
| 48 | 2.3906 | .428371E+03 | .297098E+03 | .106052E-02 | .377442E+00 | .206553E+02 | .185913E-02 | .319741E+00 | .136783E+04 |
| 49 | 2.4147 | .429007E+03 | .297073E+03 | .106047E-02 | .378019E+00 | 0. | 0. | .322230E+00 | 0. |

X= .1000000E-01 FEET TEST CASE 1 - WITH INVISCID FLOW MAPS

MOLE FRACTIONS

| PT | Y/R | O2 | N2 | :::: | :::: | | | |
|---|---|---|---|---|---|---|---|---|
| | :::: | :::: | PT | | | | | |
| 1 | .95942 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 2 | .97166 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 3 | .98918 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 4 | 1.02677 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 5 | 1.08197 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 6 | 1.13110 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 7 | 1.17689 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 8 | 1.22027 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 9 | 1.26171 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 10 | 1.30154 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 11 | 1.34001 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 12 | 1.37729 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 13 | 1.41351 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 14 | 1.44879 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 15 | 1.48322 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 16 | 1.51687 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 17 | 1.54982 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 18 | 1.58213 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 19 | 1.61383 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 20 | 1.64499 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 21 | 1.67563 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 22 | 1.70580 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 23 | 1.73552 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 24 | 1.76483 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 25 | 1.79374 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 26 | 1.82230 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 27 | 1.85051 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 28 | 1.87840 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 29 | 1.90599 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 30 | 1.93329 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 31 | 1.96033 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 32 | 1.98711 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 33 | 2.01366 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 34 | 2.03998 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 35 | 2.06608 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 36 | 2.09198 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 37 | 2.11769 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 38 | 2.14322 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 39 | 2.16858 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 40 | 2.19378 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 41 | 2.21882 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 42 | 2.24373 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 43 | 2.26850 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 44 | 2.29314 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 45 | 2.31767 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 46 | 2.34208 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 47 | 2.36639 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 48 | 2.39060 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 49 | 2.41472 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |

| XBAR | PSID | PSI(X) | Y(MPSI) | SLOPE | V/U | DEL*(X) | DEL*(X-DX) | RDIV | REFF |
|---|---|---|---|---|---|---|---|---|---|
| .208992 | .208797 | .325028 | .303353 | .012500 | -.252026 | .208872 | .221033 | 1.006014 | 1.208872 |
| .461243 | .208797 | .328328 | .305585 | .045354 | -.042037 | .179937 | .182867 | 1.020088 | 1.179937 |
| .773669 | .208797 | .329420 | .305563 | -.017112 | -.043143 | .155931 | .158938 | 1.015445 | 1.155931 |
| 1.087471 | .208797 | .329959 | .304914 | -.017985 | -.032826 | .132773 | .135059 | 1.016627 | 1.132773 |
| 1.401920 | .208797 | .330391 | .304577 | -.004437 | -.017017 | .117488 | .118674 | 1.017144 | 1.117488 |
| 1.717339 | .208797 | .330777 | .304380 | -.005355 | -.016760 | .105708 | .106877 | 1.018607 | 1.105708 |
| 2.033670 | .208797 | .331134 | .304109 | -.008136 | -.018777 | .093292 | .094601 | 1.020304 | 1.093292 |
| 2.350822 | .208797 | .331471 | .303778 | -.008503 | -.018602 | .080284 | .081579 | 1.021640 | 1.080284 |
| 2.668825 | .208797 | .331794 | .303430 | -.008686 | -.018368 | .067326 | .068603 | 1.023459 | 1.067326 |
| 2.987904 | .208797 | .332106 | .303284 | -.003912 | -.013257 | .058185 | .059109 | 1.025195 | 1.058185 |
| 3.308306 | .208797 | .332409 | .303121 | -.004223 | -.013290 | .048929 | .049856 | 1.026958 | 1.048929 |
| 3.630079 | .208797 | .332705 | .302946 | -.002404 | -.011231 | .039668 | .040453 | 1.028930 | 1.039668 |
| 3.953363 | .208797 | .332995 | .302840 | -.002723 | -.011343 | .031745 | .032539 | 1.030658 | 1.031745 |

| R/P | DELTA Y FEET | PRESS(ATM) |
|---|---|---|
| .408313E+01 | .400025E-02 | .899868E+00 |

| PT | Y/P | VELOCITY FEET/SEC | TEMPERATURE K | DENSITY GM/CC | MACH NO. | ENTH-TKE CAL/GM | VISCOSITY LB/FT/SEC | PSI | PR-RE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .8298 | .113669E+04 | .240555E+03 | .131409E-02 | .109302E+01 | 0. | 0. | .175374E+00 | 0. |
| 2 | .8457 | .109497E+04 | .241345E+03 | .131309E-02 | .106980E+01 | .360132E+03 | .796153E-03 | .178660E+00 | .966378E+06 |
| 3 | .8619 | .106785E+04 | .243624E+03 | .130211E-02 | .103844E+01 | .209404E+04 | .377171E-02 | .181946E+00 | .682882E+07 |
| 4 | .8787 | .103384E+04 | .246628E+03 | .128363E-02 | .999254E+00 | .419202E+04 | .686397E-02 | .185232E+00 | .148471E+08 |
| 5 | .8966 | .994826E+03 | .250021E+03 | .126551E-02 | .955998E+00 | .630317E+04 | .976391E-02 | .188519E+00 | .232981E+08 |
| 6 | .9149 | .954830E+03 | .253664E+03 | .124668E-02 | .910070E+00 | .825035E+04 | .123304E-01 | .191805E+00 | .310923E+08 |
| 7 | .9346 | .911325E+03 | .257493E+03 | .122753E-02 | .862173E+00 | .991850E+04 | .145431E-01 | .195091E+00 | .375145E+08 |
| 8 | .9556 | .865587E+03 | .261478E+03 | .120837E-02 | .812735E+00 | .112196E+05 | .163393E-01 | .198377E+00 | .420803E+08 |
| 9 | .9777 | .817807E+03 | .265463E+03 | .118938E-02 | .762048E+00 | .120801E+05 | .176323E-01 | .201663E+00 | .444700E+08 |
| 10 | 1.0015 | .769153E+03 | .269556E+03 | .117069E-02 | .710354E+00 | .124363E+05 | .183989E-01 | .204949E+00 | .445036E+08 |
| 11 | 1.0271 | .715825E+03 | .273683E+03 | .115243E-02 | .657902E+00 | .122368E+05 | .184959E-01 | .208236E+00 | .421506E+08 |
| 12 | 1.0547 | .661834E+03 | .277834E+03 | .113461E-02 | .604725E+00 | .114318E+05 | .178805E-01 | .211522E+00 | .374651E+08 |
| 13 | 1.0949 | .607193E+03 | .282007E+03 | .111113E-02 | .550852E+00 | .999619E+04 | .163335E-01 | .214808E+00 | .307192E+08 |
| 14 | 1.1181 | .553716E+03 | .286148E+03 | .109529E-02 | .497074E+00 | .792645E+04 | .133139E-01 | .218094E+00 | .223347E+08 |
| 15 | 1.1547 | .494782E+03 | .290188E+03 | .108001E-02 | .444651E+00 | .532725E+04 | .104613E-01 | .221380E+00 | .132368E+08 |
| 16 | 1.1952 | .444891E+03 | .293895E+03 | .106642E-02 | .397665E+00 | .270120E+04 | .626772E-02 | .224666E+00 | .560928E+07 |
| 17 | 1.2391 | .415343E+03 | .296501E+03 | .105699E-02 | .366334E+00 | .105948E+04 | .313275E-02 | .227953E+00 | .171107E+07 |
| 18 | 1.2845 | .401396E+03 | .297683E+03 | .105276E-02 | .353854E+00 | .472706E+03 | .217926E-02 | .231239E+00 | .487679E+06 |
| 19 | 1.3306 | .399666E+03 | .298035E+03 | .105152E-02 | .351599E+00 | .329523E+03 | .179225E-02 | .234525E+00 | .184755E+06 |
| 20 | 1.3756 | .400969E+03 | .298073E+03 | .105135E-02 | .352721E+00 | .296333E+03 | .173892E-02 | .237811E+00 | .105895E+06 |
| 21 | 1.4195 | .403247E+03 | .298029E+03 | .105151E-02 | .354753E+00 | .282614E+03 | .168164E-02 | .241097E+00 | .787816E+05 |
| 22 | 1.4625 | .405764E+03 | .297950E+03 | .105178E-02 | .357015E+00 | .270257E+03 | .530997E-02 | .244383E+00 | .653745E+05 |
| 23 | 1.5045 | .408304E+03 | .297861E+03 | .105204E-02 | .359303E+00 | .256619E+03 | .552513E-02 | .247670E+00 | .566513E+05 |
| 24 | 1.5456 | .410783E+03 | .297771E+03 | .105237E-02 | .361539E+00 | .242017E+03 | .556026E-02 | .250956E+00 | .500837E+05 |
| 25 | 1.5859 | .413170E+03 | .297682E+03 | .105266E-02 | .363694E+00 | .227132E+03 | .548051E-02 | .254242E+00 | .447670E+05 |
| 26 | 1.6255 | .415443E+03 | .297596E+03 | .105294E-02 | .365752E+00 | .212484E+03 | .533332E-02 | .257528E+00 | .402708E+05 |
| 27 | 1.6645 | .417603E+03 | .297514E+03 | .105321E-02 | .367704E+00 | .198360E+03 | .515123E-02 | .260814E+00 | .363444E+05 |
| 28 | 1.7028 | .419665E+03 | .297436E+03 | .105346E-02 | .369565E+00 | .184869E+03 | .495483E-02 | .264100E+00 | .328284E+05 |
| 29 | 1.7405 | .421562E+03 | .297363E+03 | .105369E-02 | .371274E+00 | .172011E+03 | .475509E-02 | .267387E+00 | .296215E+05 |
| 30 | 1.7778 | .423362E+03 | .297293E+03 | .105392E-02 | .372907E+00 | .159736E+03 | .455677E-02 | .270673E+00 | .266616E+05 |
| 31 | 1.8145 | .425056E+03 | .297224E+03 | .105413E-02 | .374440E+00 | .147986E+03 | .436155E-02 | .273959E+00 | .239123E+05 |
| 32 | 1.8509 | .426653E+03 | .297165E+03 | .105432E-02 | .375891E+00 | .136704E+03 | .416820E-02 | .277245E+00 | .213525E+05 |
| 33 | 1.8868 | .428146E+03 | .297106E+03 | .105451E-02 | .377273E+00 | .125835E+03 | .397754E-02 | .280531E+00 | .189657E+05 |
| 34 | 1.9223 | .429567E+03 | .297064E+03 | .105468E-02 | .378599E+00 | .115311E+03 | .378597E-02 | .283817E+00 | .167353E+05 |
| 35 | 1.9574 | .430952E+03 | .297033E+03 | .105487E-02 | .379872E+00 | .105065E+03 | .359746E-02 | .287104E+00 | .146438E+05 |
| 36 | 1.9922 | .432398E+03 | .296960E+03 | .105503E-02 | .381092E+00 | .950487E+02 | .339614E-02 | .290390E+00 | .126795E+05 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 37 | 2.0767 | .433675E+03 | .296844E+03 | .105519E-02 | .382269E+00 | .452561E+02 | .312412E-02 | .293676E+00 | .108416E+05 |
| 38 | 2.0609 | .434468E+03 | .296842E+03 | .105534E-02 | .383332E+00 | .757244E+02 | .299177E-02 | .295962E+00 | .913832E+04 |
| 39 | 2.0454 | .435256E+03 | .296791E+03 | .105547E-02 | .384328E+00 | .565179E+02 | .278246E-02 | .300248E+00 | .758273E+04 |
| 40 | 2.1284 | .435960E+03 | .296758E+03 | .105559E-02 | .385229E+00 | .577012E+02 | .256699E-02 | .303534E+00 | .618572E+04 |
| 41 | 2.1618 | .437443E+03 | .296723E+03 | .105569E-02 | .386030E+00 | .493150E+02 | .234234E-02 | .306821E+00 | .495196E+04 |
| 42 | 2.1950 | .438616E+03 | .296692E+03 | .105578E-02 | .386732E+00 | .413587E+02 | .210339E-02 | .310107E+00 | .387804E+04 |
| 43 | 2.2280 | .439288E+03 | .296666E+03 | .105585E-02 | .387341E+00 | .337862E+02 | .184611E-02 | .313393E+00 | .295275E+04 |
| 44 | 2.2608 | .439976E+03 | .296643E+03 | .105591E-02 | .387875E+00 | .265145E+02 | .155563E-02 | .316679E+00 | .215604E+04 |
| 45 | 2.2934 | .440413E+03 | .296622E+03 | .105596E-02 | .388362E+00 | .194785E+02 | .123256E-02 | .319965E+00 | .146853E+04 |
| 46 | 2.3258 | .440934E+03 | .296604E+03 | .105600E-02 | .388833E+00 | .127261E+02 | .875597E-03 | .323252E+00 | .882534E+03 |
| 47 | 2.3581 | .441463E+03 | .296587E+03 | .105604E-02 | .389311E+00 | .559085E+01 | .577396E-03 | .326539E+00 | .413687E+03 |
| 48 | 2.3902 | .441995E+03 | .296573E+03 | .105607E-02 | .389789E+00 | .197017E+01 | .169639E-03 | .329826E+00 | .109177E+03 |
| 49 | 2.4222 | .442394E+03 | .296563E+03 | .105608E-02 | .390152E+00 | 0. | 0. | .333110E+00 | 0. |

MOLE FRACTIONS

| PT | V/V | O2 | N2 | :::: | :::: | | | |
|---|---|---|---|---|---|---|---|---|
| | :::: | :::: | PT | | | | | |
| 1 | .82985 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 2 | .84547 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 3 | .86197 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 4 | .87871 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 5 | .89636 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 6 | .91433 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 7 | .93456 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 8 | .95543 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 9 | .97756 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 10 | 1.00145 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 11 | 1.02705 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 12 | 1.05473 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 13 | 1.08496 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 14 | 1.11813 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 15 | 1.15474 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 16 | 1.19519 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 17 | 1.23912 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 18 | 1.28487 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 19 | 1.33065 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 20 | 1.37560 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 21 | 1.41953 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 22 | 1.46246 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 23 | 1.50445 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 24 | 1.54558 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 25 | 1.58592 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 26 | 1.62552 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 27 | 1.66446 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 28 | 1.70279 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 29 | 1.74055 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 30 | 1.77779 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 31 | 1.81455 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 32 | 1.85086 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 33 | 1.88676 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 34 | 1.92227 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 35 | 1.95741 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 36 | 1.99222 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 37 | 2.02670 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 38 | 2.06088 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 39 | 2.09478 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 40 | 2.12863 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 41 | 2.16183 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 42 | 2.19501 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 43 | 2.22798 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 44 | 2.26077 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 45 | 2.29338 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 46 | 2.32582 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 47 | 2.35810 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 48 | 2.39022 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 49 | 2.42220 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |

| XBAR | PSID | PSI(X) | Y(MPSI) | SLOPE | V/U | DEL*(X) | DEL*(X-DX) | RDIV | RFFF |
|---|---|---|---|---|---|---|---|---|---|
| 4.278260 | .208797 | .333280 | .302716 | -.002914 | -.011346 | .023631 | .024427 | 1.032899 | 1.023631 |
| 4.604814 | .208797 | .333561 | .302594 | -.003077 | -.011342 | .015658 | .016456 | 1.034886 | 1.015658 |
| 4.933169 | .208797 | .333838 | .302599 | .000634 | -.007476 | .009984 | .010512 | 1.037093 | 1.009984 |
| 5.263513 | .208797 | .334111 | .302621 | .000452 | -.007517 | .004674 | .005208 | 1.039314 | 1.004674 |
| 5.595892 | .208797 | .334381 | .302636 | .000289 | -.007551 | -.000685 | -.000146 | 1.041520 | .999315 |
| 5.930325 | .208797 | .334648 | .302634 | .000122 | -.007593 | -.006261 | -.005718 | 1.043942 | .993739 |
| 6.266847 | .208797 | .334912 | .302636 | -.000011 | -.007612 | -.011711 | -.011164 | 1.046119 | .988289 |
| 6.605485 | .208797 | .335174 | .302623 | -.000146 | -.007638 | -.017366 | -.016815 | 1.048730 | .982634 |
| 6.946260 | .208797 | .335434 | .302614 | -.000259 | -.007650 | -.022890 | -.022336 | 1.051108 | .977110 |
| 7.289206 | .208797 | .335692 | .302601 | -.000353 | -.007649 | -.028445 | -.027888 | 1.053569 | .971555 |
| 7.634337 | .208797 | .335948 | .302573 | -.000458 | -.007661 | -.034186 | -.033627 | 1.056220 | .965814 |
| 7.981689 | .208797 | .336203 | .302552 | -.000534 | -.007651 | -.039789 | -.039228 | 1.059683 | .960211 |

| X/R | DELTA Y FEET | PRESS(ATM) |
|---|---|---|
| .8006331E+01 | .4355751E-02 | .8901721E+00 |

| PT | Y/R | VELOCITY FEET/SEC | TEMPERATURE F | DENSITY GM/CC | MACH NO. | ENTH-TKE CAL/GM | VISCOSITY LB/FT/SEC | PSI | PR-XE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .7079 | .1100748E+04 | .2542707E+03 | .1311617E-02 | .1072477E+01 | 0. | 0. | .1496311E+00 | 0. |
| 2 | .7267 | .1094059E+04 | .2429831E+03 | .1307459E-02 | .1067606E+01 | .2347606E+03 | .1099727E-02 | .1535206E+00 | .3063076E+06 |
| 3 | .7457 | .1087806E+04 | .2413773E+03 | .1302991E-02 | .1052722E+01 | .1369966E+04 | .9211437E-02 | .1574086E+00 | .2187196E+07 |
| 4 | .7651 | .1045111E+04 | .2452334E+03 | .1291686E-02 | .1032396E+01 | .2823206E+04 | .9413111E-02 | .1612976E+00 | .4999866E+07 |
| 5 | .7850 | .1044606E+04 | .2470122E+03 | .1282988E-02 | .1008876E+01 | .4405006E+04 | .1390027E-01 | .1651856E+00 | .8347776E+07 |
| 6 | .8054 | .1027076E+04 | .2490126E+03 | .1271116E-02 | .9831636E+00 | .6015536E+04 | .1796456E-01 | .1690746E+00 | .1193386E+08 |
| 7 | .8265 | .9979326E+03 | .2511756E+03 | .1259476E-02 | .9558286E+00 | .7509976E+04 | .2177426E-01 | .1729626E+00 | .1553746E+08 |
| 8 | .8482 | .9724456E+03 | .2534636E+03 | .1247456E-02 | .9272256E+00 | .9081096E+04 | .2579036E-01 | .1768506E+00 | .1896846E+08 |
| 9 | .8706 | .9457676E+03 | .2558486E+03 | .1235176E-02 | .8975966E+00 | .1045766E+05 | .2965736E-01 | .1807396E+00 | .2210546E+08 |
| 10 | .8938 | .9190146E+03 | .2583126E+03 | .1222766E-02 | .8671176E+00 | .1167466E+05 | .3317946E-01 | .1846276E+00 | .2483556E+08 |
| 11 | .9178 | .8892826E+03 | .2610366E+03 | .1210296E-02 | .8359266E+00 | .1272126E+05 | .3577196E-01 | .1885166E+00 | .2707366E+08 |
| 12 | .9428 | .8576406E+03 | .2641066E+03 | .1197856E-02 | .8041376E+00 | .1356976E+05 | .3757576E-01 | .1924046E+00 | .2875366E+08 |
| 13 | .9687 | .8291556E+03 | .2670116E+03 | .1185516E-02 | .7718306E+00 | .1420006E+05 | .3935956E-01 | .1962936E+00 | .2988676E+08 |
| 14 | .9957 | .7978886E+03 | .2696396E+03 | .1173296E-02 | .7391046E+00 | .1459406E+05 | .3869466E-01 | .2001816E+00 | .3026026E+08 |
| 15 | 1.0238 | .7659016E+03 | .2712796E+03 | .1161276E-02 | .7060326E+00 | .1473586E+05 | .3913176E-01 | .2040706E+00 | .3003746E+08 |
| 16 | 1.0532 | .7332616E+03 | .2719926E+03 | .1149466E-02 | .6726946E+00 | .1461216E+05 | .3923356E-01 | .2079586E+00 | .2915926E+08 |
| 17 | 1.0840 | .6998746E+03 | .2715716E+03 | .1138096E-02 | .6390016E+00 | .1420526E+05 | .3855136E-01 | .2118476E+00 | .2761716E+08 |
| 18 | 1.1164 | .6658536E+03 | .2702156E+03 | .1127176E-02 | .6050716E+00 | .1350606E+05 | .3746736E-01 | .2157356E+00 | .2544416E+08 |
| 19 | 1.1504 | .6314086E+03 | .2681976E+03 | .1116776E-02 | .5711976E+00 | .1250946E+05 | .3597766E-01 | .2196246E+00 | .2269076E+08 |
| 20 | 1.1862 | .5966956E+03 | .2654996E+03 | .1107726E-02 | .5375236E+00 | .1122026E+05 | .3377296E-01 | .2235126E+00 | .1944296E+08 |
| 21 | 1.2240 | .5624986E+03 | .2624916E+03 | .1099076E-02 | .5042906E+00 | .9654356E+04 | .2996406E-01 | .2274016E+00 | .1582026E+08 |
| 22 | 1.2639 | .5295146E+03 | .2593466E+03 | .1088186E-02 | .4718376E+00 | .7845476E+04 | .2599446E-01 | .2312896E+00 | .1199736E+08 |
| 23 | 1.3061 | .4995426E+03 | .2563696E+03 | .1073766E-02 | .4407376E+00 | .5858926E+04 | .2101116E-01 | .2351786E+00 | .8173466E+07 |
| 24 | 1.3507 | .4650406E+03 | .2531876E+03 | .1065406E-02 | .4120196E+00 | .3821016E+04 | .1541016E-01 | .2390666E+00 | .4709226E+07 |
| 25 | 1.3975 | .4390706E+03 | .2505666E+03 | .1058746E-02 | .3878016E+00 | .1988146E+04 | .9479466E-02 | .2429556E+00 | .2055606E+07 |
| 26 | 1.4461 | .4225546E+03 | .2486776E+03 | .1054316E-02 | .3724396E+00 | .4061046E+03 | .4911496E-02 | .2468436E+00 | .6502116E+06 |
| 27 | 1.4952 | .4170046E+03 | .2479416E+03 | .1052546E-02 | .3672456E+00 | .3443636E+03 | .3719596E-02 | .2507326E+00 | .1812196E+06 |
| 28 | 1.5438 | .4170086E+03 | .2479416E+03 | .1052226E-02 | .3672556E+00 | .2207016E+03 | .3617246E-02 | .2546206E+00 | .6605776E+05 |
| 29 | 1.5915 | .4187366E+03 | .2479566E+03 | .1052136E-02 | .3697346E+00 | .1865446E+03 | .4497296E-02 | .2585096E+00 | .3802306E+05 |
| 30 | 1.6383 | .4207546E+03 | .2493486E+03 | .1052566E-02 | .3705726E+00 | .1708026E+03 | .4997556E-02 | .2623976E+00 | .2916656E+05 |
| 31 | 1.6843 | .4228426E+03 | .2493116E+03 | .1052436E-02 | .3724386E+00 | .1584796E+03 | .4951296E-02 | .2662866E+00 | .2409466E+05 |
| 32 | 1.7295 | .4249036E+03 | .2493126E+03 | .1051096E-02 | .3743006E+00 | .1466406E+03 | .4921076E-02 | .2701746E+00 | .2189496E+05 |
| 33 | 1.7739 | .4268936E+03 | .2493566E+03 | .1053356E-02 | .3760956E+00 | .1349106E+03 | .4619436E-02 | .2740636E+00 | .1934916E+05 |
| 34 | 1.8176 | .4287696E+03 | .2493786E+03 | .1053606E-02 | .3778036E+00 | .1233856E+03 | .4384556E-02 | .2779516E+00 | .1704476E+05 |
| 35 | 1.8606 | .4305516E+03 | .2493126E+03 | .1051836E-02 | .3794196E+00 | .1121676E+03 | .4142566E-02 | .2818406E+00 | .1491936E+05 |
| 36 | 1.9033 | .4322356E+03 | .2493446E+03 | .1053406E-02 | .3809446E+00 | .1012886E+03 | .3931516E-02 | .2857286E+00 | .1294666E+05 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 37 | 1.9453 | .433814E+03 | .296893E+03 | .105427E-02 | .382376E+00 | .907354E+02 | .344159E-02 | .289617E+00 | .111104E+05 |
| 38 | 1.9868 | .435289E+03 | .296825E+03 | .105446E-02 | .383713E+00 | .894872E+02 | .338656E-02 | .293505E+00 | .940243E+04 |
| 39 | 2.0279 | .436653E+03 | .296770E+03 | .105464E-02 | .384950E+00 | .705422E+02 | .312741E-02 | .297394E+00 | .782226E+04 |
| 40 | 2.0686 | .437898E+03 | .296721E+03 | .105481E-02 | .386080E+00 | .509280E+02 | .286215E-02 | .301282E+00 | .637674E+04 |
| 41 | 2.1088 | .439016E+03 | .296676E+03 | .105495E-02 | .387095E+00 | .316936E+02 | .258882E-02 | .305171E+00 | .507596E+04 |
| 42 | 2.1487 | .440004E+03 | .296637E+03 | .105508E-02 | .387992E+00 | .128885E+02 | .230299E-02 | .309059E+00 | .392815E+04 |
| 43 | 2.1883 | .440866E+03 | .296603E+03 | .105519E-02 | .388774E+00 | .345419E+02 | .199342E-02 | .312948E+00 | .293516E+04 |
| 44 | 2.2276 | .441615E+03 | .296573E+03 | .105528E-02 | .389454E+00 | .266543E+02 | .167122E-02 | .316836E+00 | .209114E+04 |
| 45 | 2.2666 | .442277E+03 | .296548E+03 | .105536E-02 | .390053E+00 | .192221E+02 | .133547E-02 | .320725E+00 | .138683E+04 |
| 46 | 2.3054 | .442887E+03 | .296527E+03 | .105542E-02 | .390606E+00 | .122943E+02 | .992988E-03 | .324613E+00 | .808028E+03 |
| 47 | 2.3439 | .443463E+03 | .296508E+03 | .105548E-02 | .391126E+00 | .617945E+01 | .648338E-03 | .328502E+00 | .362452E+03 |
| 48 | 2.3822 | .443927E+03 | .296495E+03 | .105551E-02 | .391543E+00 | .174777E+01 | .169469E-03 | .332390E+00 | .886868E+02 |
| 49 | 2.4203 | .444017E+03 | .296493E+03 | .105551E-02 | .391624E+00 | 0. | 0. | .336279E+00 | 0. |

MOLE FRACTIONS

| PT | Y/R :::: | O2 :::: | N2 | :::: | :::: | | | |
|---|---|---|---|---|---|---|---|---|
| | | | PT | | | | | |
| 1 | .70786 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 2 | .72609 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 3 | .74572 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 4 | .76513 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 5 | .78501 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 6 | .80544 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 7 | .82648 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 8 | .84817 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 9 | .87059 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 10 | .89378 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 11 | .91782 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 12 | .94276 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 13 | .96868 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 14 | .99566 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 15 | 1.02379 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 16 | 1.05318 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 17 | 1.08400 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 18 | 1.11640 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 19 | 1.15043 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 20 | 1.18624 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 21 | 1.22401 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 22 | 1.26391 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 23 | 1.30610 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 24 | 1.35068 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 25 | 1.39754 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 26 | 1.44608 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 27 | 1.49515 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 28 | 1.54376 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 29 | 1.59150 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 30 | 1.63833 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 31 | 1.68430 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 32 | 1.72947 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 33 | 1.77390 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 34 | 1.81764 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 35 | 1.86076 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 36 | 1.90331 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 37 | 1.94532 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 38 | 1.98684 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 39 | 2.02790 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 40 | 2.06855 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 41 | 2.10882 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 42 | 2.14873 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 43 | 2.18832 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 44 | 2.22761 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 45 | 2.26663 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 46 | 2.30539 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 47 | 2.34392 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 48 | 2.38222 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |
| 49 | 2.42034 | .21000E+00 | .79000E+00 | 0. | 0. | 0. | 0. | 0. |

| XBAR | PSID | PSI(X) | Y(=PSI) | SLOPE | V/U | DEL*(X) | DEL*(X-DX) | RDTV | RFFF |
|---|---|---|---|---|---|---|---|---|---|
| 8.331283 | .208797 | .336456 | .302517 | -.000623 | -.007655 | -.045573 | -.045009 | 1.061429 | .954427 |
| 8.683139 | .208797 | .336707 | .302488 | -.000684 | -.007639 | -.051216 | -.050651 | 1.063998 | .948784 |
| 9.037294 | .208797 | .336957 | .302456 | -.000747 | -.007627 | -.056877 | -.056310 | 1.066729 | .943123 |
| 9.393761 | .208797 | .337206 | .302412 | -.000809 | -.007616 | -.062705 | -.062137 | 1.069464 | .937295 |
| 9.752571 | .208797 | .337454 | .302374 | -.000861 | -.007600 | -.068392 | -.067823 | 1.072066 | .931608 |
| 10.113754 | .208797 | .337701 | .302325 | -.002880 | -.009552 | -.074239 | -.073521 | 1.074971 | .925761 |
| 10.477323 | .208797 | .337946 | .302283 | -.000957 | -.007566 | -.079950 | -.079379 | 1.077755 | .920050 |
| 10.843316 | .208797 | .338191 | .302238 | -.000990 | -.007538 | -.085666 | -.085094 | 1.080512 | .914334 |
| 11.211761 | .208797 | .338436 | .302183 | -.001039 | -.007527 | -.091538 | -.090965 | 1.083461 | .908462 |
| 11.582670 | .208797 | .338679 | .302134 | -.001062 | -.007495 | -.097271 | -.096698 | 1.086300 | .902729 |
| 11.956086 | .208797 | .338922 | .302083 | -.001091 | -.007469 | -.103008 | -.102434 | 1.089179 | .896992 |

# 7. LISTING OF BOAT CODE

A complete Fortran listing of BOAT, as presently used on the NASA/ Langley CDC CYBER series is given in this section.

```
      PROGRAM BOAT (INPUT,OUTPUT,TAPE1,TAPE2,TAPE5,TAPE6=OUTPUT)                BOAT    1
C                                                                               BOAT    2
C       MAIN PROGRAM FOR BOAT                                                   BOAT    3
C                                                                               BOAT    4
C       BOATCM - BOAT COMMON                                                    BOAT    5
       DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),         BOAT    6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),             BOAT    7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),           BOAT    8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),          BOAT    9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),         BOAT   10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),              BOAT   11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),        BOAT   12
     7 XF(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),             BOAT   13
     8 YOUT(50), ZID(5)                                                         BOAT   14
C                                                                               BOAT   15
       LOGICAL LHALF,LSWON                                                      BOAT   16
C                                                                               BOAT   17
       EQUIVALENCE (J1, J12345(1))                                              BOAT   18
       EQUIVALENCE (ALOC(1,1), CM(1,1))                                         BOAT   19
       EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                            BOAT   20
       EQUIVALENCE (CPTBV, CGHV)                                                BOAT   21
       EQUIVALENCE (HCP(1,1), WM(1))                                            BOAT   22
       EQUIVALENCE (START, TTB(1))                                              BOAT   23
C                                                                               BOAT   24
       COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                     BOAT   25
       COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM      ,  CPBAR  ,BOAT   26
     1         CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX    ,  DX     ,BOAT   27
     2         DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG     ,  HSTAT  ,BOAT   28
     3         IDELP   ,  IFCC  ,  IFINIS ,  IOUT   ,  IOUT1   ,  IOUT2  ,BOAT   29
     4         IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT     ,  ISAVE  ,BOAT   30
     5         ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3      ,  J4     ,BOAT   31
     6         J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT   ,  MXNP1  ,BOAT   32
     7         NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS      ,  NT     ,BOAT   33
     8         P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI     ,  PSID   ,BOAT   34
     9         QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO     ,  RHOOUT ,BOAT   35
     1         RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB   ,  RTMAX  ,BOAT   36
     2         RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK    ,  SIGMA  ,BOAT   37
     3         T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP   ,  TITLE  ,BOAT   38
     4         TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM      ,  WP     ,BOAT   39
     5         WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD      ,  XE     ,BOAT   40
     6         XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX    ,  XMU    ,BOAT   41
     7         Y       ,  ZID                                               BOAT   42
       COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)              BOAT   43
C                                                                               BOAT   44
C       JET/EXT FLOW FIELD COMMON SECTION                                       BOAT   45
```

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C
      COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE   ,BOAT  46
     1        KMAXJ   ,  KMAXE   ,  NRJET   ,  NREXT   ,  PSJET   ,  PSEXT   ,BOAT  47
     2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE    ,BOAT  48
     3        VJET    ,  VEXT    ,  XJET    ,  XEXT                          ,BOAT  49
C                                                                             BOAT  50
      COMMON  ENDCM                                                           BOAT  51
                                                                              BOAT  52
C                                                                             BOAT  53
C     END OF COMMON TO BE COPIED TO RESTART FILE                              BOAT  54
C                                                                             BOAT  55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                                 BOAT  56
C                                                                             BOAT  57
C                                                                             BOAT  58
      CALL BOATS1                                                             BOAT  59
      CALL BOATM1                                                             BOAT  60
C                                                                             BOAT  61
      STOP                                                                    BOAT  62
      END                                                                     BOAT  63
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      SUBROUTINE BOATCC (K, I, L, NJ, NEQ, QSIGN, RMFAC)                    BCC     1
C                                                                           BCC     2
C     BOATCC - CM CALCULATIONS  - GENERALIZED (ALSO QX)                     BCC     3
C                                                                           BCC     4
      LOGICAL L510                                                          BCC     5
C      BOATCM - BOAT COMMON                                                 BCC     6
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),      BCC     7
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),         BCC     8
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),       BCC     9
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),      BCC    10
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),     BCC    11
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),          BCC    12
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),    BCC    13
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),         BCC    14
     8 YOUT(50), ZID(5)                                                     BCC    15
C                                                                           BCC    16
      LOGICAL LHALF,LSWON                                                   BCC    17
C                                                                           BCC    18
      EQUIVALENCE (J1, J12345(1))                                           BCC    19
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                      BCC    20
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                         BCC    21
      EQUIVALENCE (CPTBV, CGHV)                                             BCC    22
      EQUIVALENCE (HCP(1,1), WM(1))                                         BCC    23
      EQUIVALENCE (START, TTB(1))                                           BCC    24
C                                                                           BCC    25
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                  BCC    26
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BCC    27
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BCC    28
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BCC    29
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BCC    30
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BCC    31
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BCC    32
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BCC    33
     7        NPSI    ,  NP    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BCC    34
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BCC    35
     9        QX      ,  RALPHA,  PBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BCC    36
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BCC    37
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BCC    38
     3        T       ,  TCONT ,  TEDGE  ,  TEMPM  ,  TEMPP  ,  TITLE  ,BCC    39
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BCC    40
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BCC    41
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BCC    42
     7        Y       ,  ZID                                            BCC    43
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)          BCC    44
C                                                                           BCC    45
```

```
C      JET/EXT FLOW FIELD COMMON SECTION                                                                  BCC    46
C                                                                                                         BCC    47
       COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE   ,BCC    48
      1        KMAXJ   ,  KMAXE   ,  NRJET   ,  NREXT   ,  PSJET   ,  PSEXT   ,BCC    49
      2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE    ,BCC    50
      3        VJET    ,  VEXT    ,  XJET    ,  XEXT                           BCC    51
C                                                                                                         BCC    52
       COMMON  ENDCM                                                                                      BCC    53
C                                                                                                         BCC    54
C      END OF COMMON TO BE COPIED TO RESTART FILE                                                         BCC    55
C                                                                                                         BCC    56
       COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                                                            BCC    57
C                                                                                                         BCC    58
C                                                                                                         BCC    59
       SIGN = 1.0                                                                                         BCC    60
       L510 = (K/5)*5 .EQ. K                                                                              BCC    61
       DO 100 J = 1, NJ                                                                                   BCC    62
       IF (J .GT. 2) SIGN = -1.0                                                                          BCC    63
       IROW = IRRR(I,J)                                                                                   BCC    64
       IF (J.EQ.2 .AND. L510) IROW = 25                                                                   BCC    65
         DO 80 IEQ = 1, NEQ                                                                               BCC    66
           GO TO (10, 20, 30, 40, 50), IEQ                                                                BCC    67
10         IF (L510) GO TO 15                                                                             BCC    68
           IF (ALPHA(J1,L).EQ. 0.0) GO TO 80                                                              BCC    69
           TEMP = SIGN*TEMRP/ALPHA(J1,L)                                                                  BCC    70
           GO TO 60                                                                                       BCC    71
15         TEMP = SIGN*CRR                                                                                BCC    72
           GO TO 60                                                                                       BCC    73
20         IF (L510) GO TO 80                                                                             BCC    74
           IF (ALPHA(J2,L).EQ. 0.0) GO TO 80                                                              BCC    75
           TEMP = SIGN*TEMRP/ALPHA(J2,L)                                                                  BCC    76
           GO TO 60                                                                                       BCC    77
30     CONTINUE                                                                                           BCC    78
           IF (ALPHA(J3,L).EQ.0.0) GO TO 80                                                               BCC    79
           TEMP = -SIGN*TEMRM/ALPHA(J3,L)                                                                 BCC    80
           GO TO 60                                                                                       BCC    81
40     CONTINUE                                                                                           BCC    82
           IF (ALPHA(J4,L).EQ.0.0) GO TO 80                                                               BCC    83
           TEMP = -SIGN*TEMRM/ALPHA(J4,L)                                                                 BCC    84
           GO TO 60                                                                                       BCC    85
50     CONTINUE                                                                                           BCC    86
           IF (ALPHA(J5,L).EQ. 0.0) GO TO 80                                                              BCC    87
           TEMP = -SIGN*TEMRM/ALPHA(J5,L)                                                                 BCC    88
60         IJ = J12345(IEQ)                                                                               BCC    89
           CM(IROW,IJ) = CM(IROW,IJ) + TEMP                                                               BCC    90
```

```
80      CONTINUE                                                          BCC    91
        IF (K.EQ. 10) GO TO 100                                           BCC    92
        IF (K .EQ. 5) GO TO 85                                            BCC    93
        QX(IROW) = QX(IROW) + QSIGN*SIGN*(TEMRP + RMFAC*TEMRM)            BCC    94
        GO TO 90                                                          BCC    95
85      QX(IROW) = QX(IROW) + QSIGN*SIGN*TEMRM                            BCC    96
90      CONTINUE                                                          BCC    97
100     CONTINUE                                                          BCC    98
        RETURN                                                            BCC    99
        END                                                               BCC   100
```

```
      SUBROUTINE BOATCP                                                 BCP     1
C                                                                       BCP     2
C     BOATCP - BOAT CHECK POINT/RESTART SUBROUTINE                      BCP     3
C                                                                       BCP     4
C       BCATCM - BOAT COMMON                                            BCP     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),  BCP     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),     BCP     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),   BCP     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),  BCP     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50), BCP    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),      BCP    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BCP    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),     BCP    13
     8 YOUT(50), ZID(5)                                                 BCP    14
C                                                                       BCP    15
      LOGICAL LHALF,LSWON                                               BCP    16
C                                                                       BCP    17
      EQUIVALENCE (J1, J12345(1))                                       BCP    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                  BCP    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                     BCP    20
      EQUIVALENCE (CPTBV, CGHV)                                         BCP    21
      EQUIVALENCE (HCP(1,1), WM(1))                                     BCP    22
      EQUIVALENCE (START, TTB(1))                                       BCP    23
C                                                                       BCP    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV            BCP    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BCP    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BCP    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BCP    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BCP    29
     4        IPAGE   ,  IPPESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BCP    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BCP    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BCP    32
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BCP    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BCP    34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BCP    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BCP    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BCP    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BCP    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BCP    39
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BCP    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BCP    41
     7        Y       ,  ZID                                           BCP    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)         BCP    43
C                                                                       BCP    44
C     JET/EXT FLOW FIELD COMMON SECTION                                 BCP    45
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C                                                                       BCP    46
      COMMON  DELJ   , DFLE   , IJET   , IEXT   , IMAXJ  , IMAXE  ,BCP    47
     1        KMAXJ  , KMAXE  , NRJET  , NREXT  , PSJET  , PSEXT  ,BCP    48
     2        P1     , P2     , P3     , P4     , USTJ   , USTE   ,BCP    49
     3        VJET   , VFXT   , XJET   , XEXT                       BCP    50
C                                                                       BCP    51
      COMMON  ENDCM                                                   BCP    52
C                                                                       BCP    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BCP    54
C                                                                       BCP    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                         BCP    56
C                                                                       BCP    57
C                                                                       BCP    58
C                                                                       BCP    59
      TJAC=ETIME(TSTRT)                                               BCP    60
      RTACU=RTACU+TJAC                                                BCP    61
C                                                                       BCP    62
C      SAVE COMMON                                                      BCP    63
C                                                                       BCP    64
      NWCM=NFWAB(START,ENDCM)+1                                       BCP    65
C                                                                       BCP    66
*C     POSITION PAST RPRM SEGMENT IN FILE                               BCP    67
C                                                                       BCP    68
      REWIND 1                                                        BCP    69
      WRITE (1) (START(I),I=1,NWCM)                                   BCP    70
C                                                                       BCP    71
C     CLEAR OUT BUFFERS ON RPRM/RESTART FILE                            BCP    72
C                                                                       BCP    73
      END FILE 1                                                      BCP    74
      IF (NRAD.GT.0) END FILE 2                                       BCP    75
C                                                                       BCP    76
      WRITE (6,70) RTMAX,RTACU,RTJOB,TJAC                             BCP    77
      GO TO (10,30,20,40,50), ITFLG                                   BCP    78
10    WRITE (6,80)                                                    BCP    79
      GO TO 60                                                        BCP    80
20    WRITE (6,90)                                                    BCP    81
      GO TO 60                                                        BCP    82
30    WRITE (6,100)                                                   BCP    83
      GO TO 60                                                        BCP    84
40    WRITE (6,110) NAMAS,NPAS                                        BCP    85
      GO TO 60                                                        BCP    86
50    WRITE (6,120)                                                   BCP    87
60    STOP                                                            BCP    88
C                                                                       BCP    89
70    FORMAT (/15H MAX RUN TIME =,F8.2,5X,22HACCUMULATED RUN TIME =,F8.2BCP    90
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     1/15H MAX JOB TIME =,F8.2,5X,22HACCUMULATED JOB TIME =,F8.2//)      BCP    91
                                                                        BCP    92
80    FORMAT (/23H RUN TERMINATED BY SW 0)                              BCP    93
90    FORMAT (/43H MAX RUN TIME EXCEEDED, BOAT RUN TERMINATED)          BCP    94
100   FORMAT (/43H MAX JOB TIME EXCEEDED, BOAT JOB TERMINATED)          BCP    95
110   FORMAT (/44H RUN TERMINATED DUE TO INSUFFICIENT ROOM IN ,3A2,9H, NBCP    96
     1REC = ,I5,10H, NWPR = 1/25H EXPAND FILE AND RESTART )             BCP    97
120   FORMAT (/49H XMAX EXCEEDED, XMAX WILL BE DOUBLED, RESTART TO ,12HCBCP    98
     1ONTINUE RUN)                                                      BCP    99
      END
```

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      SUBROUTINE BOATDS (PSNEW)                                          BDS     1
C                                                                        BDS     2
C     DELSTAR OUTPUT ROUTINE                                             BDS     3
C                                                                        BDS     4
C      BOATCM - BOAT COMMON                                              BDS     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),   BDS     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),      BDS     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),    BDS     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),   BDS     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),  BDS    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),       BDS    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BDS    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),      BDS    13
     8 YOUT(50), ZID(5)                                                  BDS    14
C                                                                        BDS    15
      LOGICAL LHALF,LSWON                                                BDS    16
C                                                                        BDS    17
      EQUIVALENCE (J1, J12345(1))                                        BDS    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                   BDS    19
      EQUIVALENCE (ECC, CP(1,13)), (YOUT, CM(1,15))                      BDS    20
      EQUIVALENCE (CPTBV, CGHV)                                          BDS    21
      EQUIVALENCE (HCP(1,1), WM(1))                                      BDS    22
      EQUIVALENCE (START, TTR(1))                                        BDS    23
C                                                                        BDS    24
      COMMON  TTB(30), HF(25) , CPTBV , GTBV , HTBV                      BDS    25
      COMMON  A      , AID    , ALPHA , CARB , CM     , CPBAR  ,BDS    26
     1        CRR    , CVISC  , DELPSI , DFDL , DPDX   , DX     ,BDS    27
     2        DXMIN  , FDL    , FFF   , G    , GGG    , HSTAT  ,BDS    28
     3        IDELP  , IFCC   , IFINIS , IOUT , IOUT1  , IOUT2  ,BDS    29
     4        IPAGE  , IPRESS , IPR   , IRRR , IRT    , ISAVE  ,BDS    30
     5        ITFLG  , IVIS   , J1    , J2   , J3     , J4     ,BDS    31
     6        J5     , LHALF  , MMOD  , MPSI , MXNPT  , MXNP1  ,BDS    32
     7        NPSI   , NR     , NRAD  , NRAS , NS     , NT     ,BDS    33
     8        P      , PCNT   , PPNT  , PRNTXC , PSI  , PSID   ,BDS    34
     9        QX     , RALPHA , RRUDY , RC   , RHO    , RHOOUT ,BDS    35
     1        RJ     , RT     , RTACU , RTJAC , RTJOB  , RTMAX  ,BDS    36
     2        RU     , RXE    , RXK   , SIGE , SIGK   , SIGMA  ,BDS    37
     3        T      , TCONT  , TEDGE , TEMRM , TEMRP  , TITLE  ,BDS    38
     4        TKINET , U      , UNIT  , WDOT , WM     , WP     ,BDS    39
     5        WTMIX  , WTMOLE , X     , XCHANG , XD   , XE     ,BDS    40
     6        XINIT  , XK     , XK2   , XLE  , XMAX   , XMU    ,BDS    41
     7        Y      , ZID                                      BDS    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)          BDS    43
C                                                                        BDS    44
C     JET/EXT FLOW FIELD COMMON SECTION                                  BDS    45
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C
      COMMON  DELJ   ,  DELE   ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  ,BDS    46
     1        KMAXJ  ,  KMAXE  ,  NRJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BDS    47
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE   ,BDS    48
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                        BDS    49
C                                                                       BDS    50
      COMMON  ENDCM                                                     BDS    51
C                                                                       BDS    52
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BDS    53
C                                                                       BDS    54
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BDS    55
C                                                                       BDS    56
C                                                                       BDS    57
      IF (PSID.EQ.0) GO TO 30                                           BDS    58
      DO 10 I=2,MPSI                                                    BDS    59
      IF (PSI(I).GE.PSID) GO TO 20                                      BDS    60
10    CONTINUE                                                          BDS    61
20    RAT=(PSID-PSI(I-1))/(PSI(I)-PSI(I-1))                             BDS    62
      RDIV=Y(I-1)+RAT*(Y(I)-Y(I-1))                                     BDS    63
      RHODIV=RHO(I-1)+RAT*(RHO(I)-RHO(I-1))                             BDS    64
30    CONTINUE                                                          BDS    65
      TERMSI=PSNEW**2-PSI(MPSI)**2                                      BDS    66
      VOU=-TERMSI/2./RHO(MPSI)/U(MPSI)/Y(MPSI)/DX*XK2                   BDS    67
      VOUP=VOU                                                          BDS    68
      VOU=VOU*Y(MPSI)/RDIV                                              BDS    69
      VOU=VOU*RHO(MPSI)/RHODIV                                          BDS    70
      DELE=DELJ+VOU*DX/PJ                                               BDS    71
      RDIV=RDIV/RJ                                                      BDS    72
      REFF=1.0+DELE                                                     BDS    73
      XBAR=X/PJ                                                         BDS    74
      IPRT=10                                                           BDS    75
      ICT=ICT+1                                                         BDS    76
      IF (ICT.EQ.IPRT) ICT=0                                            BDS    77
      IF (ICT.GT.0) GO TO 40                                            BDS    78
      WRITE (6,50) XBAR,PSID,PSNEW,Y(MPSI),XK2,VJUP,DELE,DELJ,RDIV,REFF BDS    79
40    CONTINUE                                                          BDS    80
      DELJ=DELE                                                         BDS    81
      RETURN                                                            BDS    82
C                                                                       BDS    83
50    FORMAT (10F10.6)                                                  BDS    84
      END                                                               BDS    85
                                                                        BDS    86
```

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      SUBROUTINE BOATEN (PSII,PSIE)                                          BEN     1
C                                                                            BEN     2
C     ENTRAINMENT FOR SHEAR LAYER GROWTH                                     BEN     3
C                                                                            BEN     4
C       BOATCM - BOAT COMMON                                                 BEN     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),       BEN     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),          BEN     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),        BEN     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),       BEN     9
     4 RC(40,3), RHU(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),      BEN    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),           BEN    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),     BEN    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),          BEN    13
     8 YOUT(50), ZID(5)                                                      BEN    14
C                                                                            BEN    15
      LOGICAL LHALF,LSWON                                                    BEN    16
C                                                                            BEN    17
      EQUIVALENCE (J1, J12345(1))                                            BEN    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                       BEN    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                          BEN    20
      EQUIVALENCE (CPTBV, CGHV)                                              BEN    21
      EQUIVALENCE (HCP(1,1), WM(1))                                          BEN    22
      EQUIVALENCE (START, TTB(1))                                            BEN    23
                                                                             BEN    24
C                                                                            BEN    25
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                   BEN    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BEN  26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BEN  27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BEN  28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BEN  29
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BEN  30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BEN  31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BEN  32
     7        NPSI    ,  NP    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BEN  33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BEN  34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BEN  35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BEN  36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BEN  37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BEN  38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BEN  39
     5        WTMIX   ,  WTMOLF,  X      ,  XCHANG ,  XD     ,  XE     ,BEN  40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BEN  41
     7        Y       ,  ZID                                               BEN  42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)            BEN  43
C                                                                            BEN  44
C     JET/EXT FLOW FIELD COMMON SECTION                                      BEN  45
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C                                                                       BEN    46
      COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE  ,BEN    47
     1        KMAXJ   ,  KMAXE   ,  NRJET   ,  NREXT   ,  PSJET   ,  PSEXT  ,BEN    48
     2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE   ,BEN    49
     3        VJET    ,  VEXT    ,  XJET    ,  XEXT                          BEN    50
C                                                                       BEN    51
      COMMON  ENDCM                                                     BEN    52
C                                                                       BEN    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BEN    54
C                                                                       BEN    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BEN    56
C                                                                       BEN    57
C                                                                       BEN    58
      IL=ISAVE(1)                                                       BEN    59
      XL=SPACR(3)                                                       BEN    60
      IF (PSI(1).EQ.0) GO TO 30                                         BEN    61
      PSIX=(XMU(2)+XMU(3))*(Y(2)+Y(3))/(Y(3)-Y(2))/2./PSI(1)            BEN    62
      IF (IVIS.LT.0) PSIX=3.*Y(3)*XMU(2)*(Y(3)-Y(1))/(Y(2)-Y(1))**2/PSI(BEN    63
     11)                                                                BEN    64
      IF (IVIS.LT.1) GO TO 10                                           BEN    65
      RAT=(U(1)-U(2))/(U(1)-U(MPSI))*(Y(MPSI)-Y(1))/(Y(2)-Y(1))         BEN    66
      IF (ABS(RAT).LT..1) PSIX=0.                                       BEN    67
10    CONTINUE                                                          BEN    68
      IF (IVIS.NE.0) GO TO 20                                           BEN    69
      IF (IL.NE.0) XL=SPACR(1)                                          BEN    70
      PSIX=4.*RHO(1)*Y(1)/PSI(1)*XL**2*ABS(U(2)-U(1))/(Y(2)-Y(1))**2    BEN    71
20    CONTINUE                                                          BEN    72
      PSII=PSI(1)-PSIX*DX                                               BEN    73
C                                                                       BEN    74
C     STEP SIZE REDUCED WHEN MIXING HITS AXIS                           BEN    75
C                                                                       BEN    76
      IF (PSII.LT.0.) FDL=.1                                            BEN    77
      IF (PSII.LT.0.) DFDL=.1                                           BEN    78
C                                                                       BEN    79
      IF (PSII.LE.0.) PSII=0.                                           BEN    80
30    CONTINUE                                                          BEN    81
      L=MPSI-2                                                          BEN    82
      K=MPSI-1                                                          BEN    83
      PSIX=(XMU(K)+XMU(L))*(Y(K)+Y(L))/(Y(K)-Y(L))/2./PSI(MPSI)         BEN    84
      IF (IVIS.LT.0) PSIX=3.*Y(L)*XMU(K)*(Y(MPSI)-Y(L))/(Y(MPSI)-Y(K))**BEN    85
     12/PSI(MPSI)                                                       BEN    86
      IF (IVIS.LT.1) GO TO 40                                           BEN    87
      RAT=(U(MPSI)-U(NPSI))/(U(1)-U(MPSI))*(Y(MPSI)-Y(1))/(Y(MPSI)-Y(NPSBEN    88
     1I))                                                               BEN    89
      IF (ABS(RAT).LT..1) PSIX=0.                                       BEN    90
```

```
40      CONTINUE                                                              BEN    91
        IF (IVIS.NE.0) GO TO 50                                               BEN    92
        IF (IL.NE.0) XL=SPACR(2)                                              BEN    93
        PSIX=4.*RHO(MPSI)*Y(MPSI)/PSI(MPSI)*XL**2*ABS(U(MPSI)-U(NPSI))/(Y(BEN    94
       1MPSI)-Y(NPSI))**2                                                     BEN    95
50      CONTINUE                                                              BEN    96
        PSIE=PSI(MPSI)+PSIX*DX                                                BEN    97
        RETURN                                                                BEN    98
        END                                                                   BEN    99
```

```
      SUBROUTINE BOATIF                                                      BIF     1
C                                                                            BIF     2
C     INVISCID FLOW MAP ROUTINE                                              BIF     3
C                                                                            BIF     4
C       BOATCM - BOAT COMMON                                                 BIF     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),       BIF     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),          BIF     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),        BIF     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),       BIF     9
     4 RC(40,3), RHJ(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),      BIF    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),           BIF    11
     6 VJET(4,25,2), WOUT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),     BIF    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),          BIF    13
     8 YOUT(50), ZID(5)                                                      BIF    14
C                                                                            BIF    15
      LOGICAL LHALF,LSWOM                                                    BIF    16
C                                                                            BIF    17
      EQUIVALENCE (J1, J12345(1))                                            BIF    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                       BIF    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                          BIF    20
      EQUIVALENCE (CPTBV, CGHV)                                              BIF    21
      EQUIVALENCE (HCP(1,1), WM(1))                                          BIF    22
      EQUIVALENCE (START, TTB(1))                                            BIF    23
C                                                                            BIF    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                   BIF    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BIF    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BIF    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BIF    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BIF    29
     4        IPAGE   ,  IPRESS,  IPR    ,  IRRR   ,  IRT    ,  ISAVE  ,BIF    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BIF    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BIF    32
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BIF    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BIF    34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BIF    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BIF    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BIF    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BIF    38
     4        TKINET  ,  U     ,  UNIT   ,  WOOT   ,  WM     ,  WP     ,BIF    39
     5        WTMIX   ,  WTMOLF,  X      ,  XCHANG ,  XD     ,  XE     ,BIF    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BIF    41
     7        Y       ,  ZID                                              BIF    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)            BIF    43
C                                                                            BIF    44
C     JET/EXT FLOW FIELD COMMON SECTION                                      BIF    45
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C                                                                       BIF    46
      COMMON  DELJ   ,  DELE   ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  ,BIF    47
     1        KMAXJ  ,  KMAXE  ,  NRJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BIF    48
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE   ,BIF    49
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                         BIF    50
C                                                                       BIF    51
      COMMON  ENDCM                                                     BIF    52
C                                                                       BIF    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BIF    54
C                                                                       BIF    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BIF    56
C                                                                       BIF    57
C                                                                       BIF    58
C     INVISCID FILE CREATION ROUTINE                                    BIF    59
      DIMENSION HOLD(25), HOLD1(25), IFLOW(2)                           BIF    60
      DIMENSION IMAXV(2), NRECV(2), XJEV(50,2)                          BIF    61
      EQUIVALENCE (IMAXV,IMAXJ), (NRECV,NRJET), (XJEV,XJET)            BIF    62
C                                                                       BIF    63
      DATA IFLOW/2HJE,2HEX/                                             BIF    64
C     25 RADIAL LOCATIONS,50 AXIAL LOCATIONS                            BIF    65
C                                                                       BIF    66
C     STARTING RECORD NO. OF FLOW FIELDS FOR JET/EXT (NWPR=1)           BIF    67
C                                                                       BIF    68
      NREC=1                                                            BIF    69
C                                                                       BIF    70
C     READ INVISCID DATA ARRAYS                                         BIF    71
C                                                                       BIF    72
      DO 100 IP=1,IPRESS                                                BIF    73
      IMAX=IMAXV(IP)                                                    BIF    74
      NRECV(IP)=NREC                                                    BIF    75
      WRITE (6,150) IFLOW(IP)                                           BIF    76
      DO 90 I=1,IMAX                                                    BIF    77
      IF (IP.EQ.1) READ (5,140) LMAP,XJET(I)                            BIF    78
      IF (IP.EQ.2) READ (5,140) LMAP,XEXT(I)                            BIF    79
      DO 10 J=1,4                                                       BIF    80
      READ (5,160) (VJET(J,K,1),K=1,LMAP)                               BIF    81
10    CONTINUE                                                          BIF    82
C     VJET(1,K,1)=Y;VJET(2,K,1)=P;VJET(3,K,1)=T;VJET(4,K,1)=U           BIF    83
C                                                                       BIF    84
C     MASS FLOW INTEGRATION                                             BIF    85
C                                                                       BIF    86
      HOLD(1)=0.                                                        BIF    87
      IF (IP.EQ.2) HOLD(1)=PSJET**2                                     BIF    88
      IF (IP.EQ.1) WDUM=SMPR2(NS,ALPHA(1,1),WTMOLE)                     BIF    89
      IF (IP.EQ.2) WDUM=SMPR2(NS,ALPHA(1,MPSI),WTMOLE)                  BIF    90
```

```
      DUM1=VJET(2,1,1)*WDUM*VJET(4,1,1)/VJET(3,1,1)                    BIF    91
      DO 20 K=2,LMAP                                                   BIF    92
      DUM2=VJET(2,K,1)*WDUM*VJET(4,K,1)/VJET(3,K,1)                    BIF    93
      TERM=.5*(DUM1+DUM2)                                              BIF    94
      TERM=TERM/42.285                                                 BIF    95
      HOLD(K)=HOLD(K-1)+TERM*(VJET(1,K,1)**2-VJET(1,K-1,1)**2)         BIF    96
      DUM1=DUM2                                                        BIF    97
20    CONTINUE                                                         BIF    98
      DO 30 K=1,LMAP                                                   BIF    99
30    HOLD(K)=SQRT(HOLD(K))                                            BIF   100
      IF (IP.EQ.1.AND.I.EQ.1) PSJET=HOLD(LMAP)                         BIF   101
      IF (IP.EQ.2) PSEXT(I)=HOLD(LMAP)                                 BIF   102
C                                                                      BIF   103
C     NONDIMENSIONALIZE MASS FLOW                                      BIF   104
C                                                                      BIF   105
      HOLDS=HOLD(1)                                                    BIF   106
      DO 40 K=1,LMAP                                                   BIF   107
      HOLD(K)=(HOLD(K)-HOLDS)/(HOLD(LMAP)-HOLDS)                       BIF   108
40    CONTINUE                                                         BIF   109
C                                                                      BIF   110
C     INTERPOLATE ONTO EVENLY SPACED ARRAY                             BIF   111
C                                                                      BIF   112
      IF (IP.EQ.1) KMAX=KMAXJ                                          BIF   113
      IF (IP.EQ.2) KMAX=KMAXE                                          BIF   114
      DO 70 LL=1,4                                                     BIF   115
      DO 50 K=1,LMAP                                                   BIF   116
      HOLD1(K)=VJET(LL,K,1)                                            BIF   117
50    CONTINUE                                                         BIF   118
      DO 60 K=1,KMAX                                                   BIF   119
      PSDUM=FLOAT(K-1)/FLOAT(KMAX-1)                                   BIF   120
      CALL BOATLI (PSDUM,VEXT(LL,K,1),HOLD,HOLD1,LMAP)                 BIF   121
60    CONTINUE                                                         BIF   122
70    CONTINUE                                                         BIF   123
C                                                                      BIF   124
      PMFLO=PSJET                                                      BIF   125
      IF (IP.EQ.2) PMFLO=PSEXT(I)                                      BIF   126
      WRITE (6,170) I,XJEV(I,IP),PMFLO                                 BIF   127
      DO 80 K=1,KMAX                                                   BIF   128
      PSDUM=FLOAT(K-1)/FLOAT(KMAX-1)                                   BIF   129
      WRITE (6,180) K,(VEXT(J,K,1),J=1,4),PSDUM                        BIF   130
80    CONTINUE                                                         BIF   131
C                                                                      BIF   132
C     WRITE ON DISC                                                    BIF   133
C                                                                      BIF   134
      CALL PBFDW (FID,NREC,4*KMAX,VEXT)                                BIF   135
```

```
C                                                                       BIF  136
90    CONTINUE                                                          BIF  137
100   CONTINUE                                                          BIF  138
C                                                                       BIF  139
C     READ INITIAL TWO STATIONS OF JET MAP                              BIF  140
C                                                                       BIF  141
      DO 110 I=1,2                                                      BIF  142
      CALL PBFDR (FID,NRJET,4*KMAXJ,VJET(1,1,I))                        BIF  143
110   CONTINUE                                                          BIF  144
      IJET=2                                                            BIF  145
      IF (IPRESS.EQ.1) GO TO 130                                        BIF  146
C                                                                       BIF  147
C     READ INITIAL TWO STATIONS OF EXT MAP                              BIF  148
C                                                                       BIF  149
      DO 120 I=1,2                                                      BIF  150
      CALL PBFDR (FID,NREXT,4*KMAXE,VEXT(1,1,I))                        BIF  151
120   CONTINUE                                                          BIF  152
      IEXT=2                                                            BIF  153
130   CONTINUE                                                          BIF  154
      RETURN                                                            BIF  155
C                                                                       BIF  156
140   FORMAT (I2,3X,7E10.3)                                             BIF  157
150   FORMAT (1H1,40X,A2,14HT,INVISCID MAP)                             BIF  158
160   FORMAT (8E10.3)                                                   BIF  159
170   FORMAT (///15H STATION NUMBER,I4,10X,16HAXIAL LOCATION =,E13.5,10XBIF  160
     1,21HMASS FLOW PARAMETER =,E13.5//4X,2HPT,14X,1HY,12X,1HP,12X,1HT,1BIF  161
     22X,1HU,7X,6HPSIBAR)                                               BIF  162
180   FORMAT (1H ,I5,2X,8E13.5)                                         BIF  163
      END                                                               BIF  164
```

```
      SUBROUTINE BOATII (ITYP,XX,PSIX,IMAXV,KMAXV,IV,VECT,XV,PSV,V1,V2,VBII     1
     13,V4,PSJ,FID,NREC)
C                                                                        BII     2
C     INVISCID INTERPOLATION ROUTINE                                     BII     3
C                                                                        BII     4
      DIMENSION VECT(4,25,2), XV(50), PSV(50), VV(4)                     BII     5
      IF (XX.LE.XV(IV)) GO TO 10                                         BII     6
      CALL SFVMV (VECT(1,1,2),VECT(1,1,1),100)                           BII     7
C     READ IN NEXT FILE STATION AND UP IV COUNTER                        BII     8
C                                                                        BII     9
      CALL PBFOR (FID,NREC,4*KMAXV,VECT(1,1,2))                          BII    10
C                                                                        BII    11
      IV=IV+1                                                            BII    12
      IF (IV.LE.IMAXV) GO TO 10                                          BII    13
      WRITE (6,30)                                                       BII    14
      STOP                                                               BII    15
10    CONTINUE                                                           BII    16
      RATX=(XX-XV(IV-1))/(XV(IV)-XV(IV-1))                               BII    17
      IF (ITYP.EQ.1.OR.ITYP.EQ.3) PSVV=PSV(1)                            BII    18
      IF (ITYP.EQ.2.OR.ITYP.EQ.4) PSVV=PSV(IV-1)+RATX*(PSV(IV)-PSV(IV-1))BII    19
     1)                                                                  BII    20
      DSI=1./FLOAT(KMAXV-1)                                              BII    21
      IF (ITYP.EQ.1.OR.ITYP.EQ.3) SIBAR=PSIX/PSVV                        BII    22
      IF (ITYP.EQ.2.OR.ITYP.EQ.4) SIBAR=(PSIX-PSJ)/(PSVV-PSJ)            BII    23
      KV=SIBAR/DSI+1                                                     BII    24
      IF (KV.LT.1) KV=1                                                  BII    25
      RATSI=(SIBAR-FLOAT(KV-1)*DSI)/DSI                                  BII    26
      DO 20 M=1,4                                                        BII    27
      DUM1=VECT(M,KV,1)+RATSI*(VECT(M,KV+1,1)-VECT(M,KV,1))              BII    28
      DUM2=VECT(M,KV,2)+RATSI*(VECT(M,KV+1,2)-VECT(M,KV,2))              BII    29
      VV(M)=DUM1+RATX*(DUM2-DUM1)                                        BII    30
      IF (ITYP.GT.2) VV(M)=(DUM2-DUM1)/(XV(IV)-XV(IV-1))                 BII    31
20    CONTINUE                                                           BII    32
C     V1=Y, V2=P, V3=T, V4=U                                             BII    33
      V1=VV(1)                                                           BII    34
      V2=VV(2)+2117.                                                     BII    35
      V3=VV(3)                                                           BII    36
      V4=VV(4)                                                           BII    37
      RETURN                                                             BII    38
C                                                                        BII    39
30    FORMAT (23H BOATII - IV .GT. IMAXV)                                BII    40
      END                                                                BII    41
                                                                         BII    42
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      SUBROUTINE BOATIN                                                 BIN     1
C                                                                       BIN     2
C     INITIAL DATA OUTPUT                                               BIN     3
C                                                                       BIN     4
C       BOATCM - BOAT COMMON                                            BIN     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),  BIN     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),     BIN     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),   BIN     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),  BIN     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50), BIN    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),      BIN    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BIN    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),     BIN    13
     8 YOUT(50), ZID(5)                                                 BIN    14
C                                                                       BIN    15
      LOGICAL LHALF,LSWON                                               BIN    16
C                                                                       BIN    17
      EQUIVALENCE (J1, J12345(1))                                       BIN    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                  BIN    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                     BIN    20
      EQUIVALENCE (CPTBV, CGHV)                                         BIN    21
      EQUIVALENCE (HCP(1,1), WM(1))                                     BIN    22
      EQUIVALENCE (START, TTB(1))                                       BIN    23
C                                                                       BIN    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                BIN    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BIN    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BIN    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BIN    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BIN    29
     4        IPAGE   ,  IPRESS ,  IRR   ,  IRRR   ,  IRT    ,  ISAVE  ,BIN    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BIN    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BIN    32
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BIN    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNIXC ,  PSI    ,  PSID   ,BIN    34
     9        QX      ,  RALPHA ,  RBUOY ,  RC     ,  RHO    ,  RHOOUT ,BIN    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BIN    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BIN    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BIN    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BIN    39
     5        WTMIX   ,  WTMOLE ,  X     ,  XCHANG ,  XD     ,  XE     ,BIN    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BIN    41
     7        Y       ,  ZID                                             BIN    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)         BIN    43
C                                                                       BIN    44
C     JET/EXT FLOW FIELD COMMON SECTION                                 BIN    45
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C                                                                       BIN    46
      COMMON  DELJ   ,  DELE   ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  ,BIN    47
     1        KMAXJ  ,  KMAXE  ,  NRJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BIN    48
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE   ,BIN    49
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                         BIN    50
C                                                                       BIN    51
      COMMON  ENDCM                                                     BIN    52
C                                                                       BIN    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BIN    54
C                                                                       BIN    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BIN    56
C                                                                       BIN    57
C                                                                       BIN    58
      CALL DATE (RDATE)                                                 BIN    59
      WRITE (6,300)                                                     BIN    60
      WRITE (6,310)                                                     BIN    61
      WRITE (6,320) (TITLE(I),I=1,19)                                   BIN    62
      WRITE (6,150) IFNAM,NAMAS,RDATE                                   BIN    63
      IF (IPRESS.NE.0) WRITE (6,330) P                                  BIN    64
      IF (IPRESS.EQ.0) WRITE (6,340) P                                  BIN    65
      WRITE (6,370) RJ,RBUOY                                            BIN    66
      WRITE (6,380) XLE(1),SIGMA(1)                                     BIN    67
      WRITE (6,410) X,XMAX                                              BIN    68
      WRITE (6,420) PRNT,DXMIN                                          BIN    69
      IF (IVIS.LT.0) WRITE (6,160)                                      BIN    70
      IF (IVIS.EQ.0) WRITE (6,170)                                      BIN    71
      IF (IVIS.EQ.1) WRITE (6,180)                                      BIN    72
      WRITE (6,390)                                                     BIN    73
      WRITE (6,350) T(1),T(MPSI)                                        BIN    74
      WRITE (6,360) U(1),U(MPSI)                                        BIN    75
      WTMIX(1)=0.0                                                      BIN    76
      WTMIX(MPSI)=0.0                                                   BIN    77
      DO 10 J=1,NS                                                      BIN    78
      WTMIX(1)=WTMIX(1)+ALPHA(J,1)                                      BIN    79
10    WTMIX(MPSI)=WTMIX(MPSI)+ALPHA(J,MPSI)                             BIN    80
      DO 20 J=1,NS                                                      BIN    81
      RALPHA(J,1)=ALPHA(J,1)/WTMIX(1)                                   BIN    82
      RALPHA(J,MPSI)=ALPHA(J,MPSI)/WTMIX(MPSI)                          BIN    83
20    WRITE (6,400) AID(J),RALPHA(J,1),RALPHA(J,MPSI)                   BIN    84
      IF (NR.LE.0) GO TO 140                                            BIN    85
      WRITE (6,190)                                                     BIN    86
      DO 130 I=1,NR                                                     BIN    87
      L=IRR(I)                                                          BIN    88
      GO TO (30,40,50,60,70,90,90,100,110,120), L                       BIN    89
30    J1=IRR(I,1)                                                       BIN    90
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      J2=IRRR(I,2)                                                          BIN   91
      J3=IRRR(I,3)                                                          BIN   92
      J4=IRRR(I,4)                                                          BIN   93
      WRITE (6,200) I,AID(J1),AID(J2),AID(J3),AID(J4),(RC(I,J),J=1,3)       BIN   94
      GO TO 130                                                             BIN   95
40    J1=IRRR(I,1)                                                          BIN   96
      J2=IRRR(I,2)                                                          BIN   97
      J3=IRRR(I,3)                                                          BIN   98
      WRITE (6,210) I,AID(J1),AID(J2),AID(J3),(RC(I,J),J=1,3)               BIN   99
      GO TO 130                                                             BIN  100
50    J1=IRRR(I,1)                                                          BIN  101
      J2=IRRR(I,2)                                                          BIN  102
      J3=IRRR(I,3)                                                          BIN  103
      J4=IRRR(I,4)                                                          BIN  104
      J5=IRRR(I,5)                                                          BIN  105
      WRITE (6,220) I,AID(J1),AID(J2),AID(J3),AID(J4),AID(J5),(RC(I,J),JBIN  106
     1=1,3)                                                                 BIN  107
      GO TO 130                                                             BIN  108
60    J1=IRRR(I,1)                                                          BIN  109
      J2=IRRR(I,2)                                                          BIN  110
      J3=IRRR(I,3)                                                          BIN  111
      WRITE (6,230) I,AID(J1),AID(J2),AID(J3),(RC(I,J),J=1,3)               BIN  112
      GO TO 130                                                             BIN  113
70    J1=IRRR(I,1)                                                          BIN  114
      J2=IRRR(I,3)                                                          BIN  115
      J3=IRRR(I,4)                                                          BIN  116
      WRITE (6,240) I,AID(J1),AID(J2),AID(J3),(RC(I,J),J=1,3)               BIN  117
      GO TO 130                                                             BIN  118
80    J1=IRRR(I,1)                                                          BIN  119
      J2=IRRR(I,2)                                                          BIN  120
      J3=IRRR(I,3)                                                          BIN  121
      J4=IRRR(I,4)                                                          BIN  122
      WRITE (6,250) I,AID(J1),AID(J2),AID(J3),AID(J4),(RC(I,J),J=1,3)       BIN  123
      GO TO 130                                                             BIN  124
90    J1=IRRR(I,1)                                                          BIN  125
      J2=IRRR(I,2)                                                          BIN  126
      J3=IRRR(I,3)                                                          BIN  127
      WRITE (6,260) I,AID(J1),AID(J2),AID(J3),(RC(I,J),J=1,3)               BIN  128
      GO TO 130                                                             BIN  129
100   J1=IRRR(I,1)                                                          BIN  130
      J2=IRRR(I,2)                                                          BIN  131
      J3=IRRR(I,3)                                                          BIN  132
      J4=IRRR(I,4)                                                          BIN  133
      J5=IRRR(I,5)                                                          BIN  134
      WRITE (6,270) I,AID(J1),AID(J2),AID(J3),AID(J4),AID(J5),(RC(I,J),JBIN  135
```

```
     1=1,3)                                                                    BIN  136
      GO TO 130                                                                BIN  137
110   J1=IRRR(I,1)                                                            BIN  138
      J2=IRRR(I,2)                                                             BIN  139
      J3=IRRR(I,3)                                                             BIN  140
      WRITE (6,280) I,AID(J1),AID(J2),AID(J3),(RC(I,J),J=1,3)                  BIN  141
      GO TO 130                                                                BIN  142
120   J1=IRRR(I,1)                                                            BIN  143
      J2=IRRR(I,2)                                                             BIN  144
      J3=IRRR(I,3)                                                             BIN  145
      WRITE (6,290) I,AID(J1),AID(J2),AID(J3),(RC(I,J),J=1,3)                  BIN  146
130   CONTINUE                                                                 BIN  147
140   CONTINUE                                                                 BIN  148
      RETURN                                                                   BIN  149
C                                                                              BIN  150
150   FORMAT (1HO,22X,43HINITIALIZATION OF BOAT RUN, RESTART FILE - ,3A2BIN  151
     1,21H, BOAT-SPECRA FILE - ,3A2,5X,A10)                                    BIN  152
160   FORMAT (1HO,22X,20HKE2 TURBULENCE MODEL)                                 BIN  153
170   FORMAT (1HO,22X,27HPRANDTL MIXING LENGTH MODEL)                          BIN  154
180   FORMAT (1HO,22X,20HDONALDSON/GRAY MODEL)                                 BIN  155
190   FORMAT (1HO,19X,26HREACTIONS BEING CONSIDERED,6X,15HKR=A*EXP(B/RT)BIN  156
     1/,4HT**N,7X,1HA,8X,1HN,9X,1HB,7X,23H(MOLECULE-ML-SEC UNITS))            BIN  157
200   FORMAT (I9,9X,A6,2H+ ,A6,8X,2H= ,A6,2H+ ,A6,18X,1E10.4,2X,F4.1,2X,BIN  158
     1F10.1)                                                                  BIN  159
210   FORMAT (I9,9X,A6,2H+ ,A6,3H+ M,5X,2H= ,A6,3H+ M,23X,1E10.4,2X,F4.1BIN  160
     1,2X,F10.1)                                                              BIN  161
220   FORMAT (I9,9X,A6,2H+ ,A6,8X,2H= ,A6,2H+ ,A6,2H+ ,A6,10X,E9.3,2X,F4BIN  162
     1.1,2X,F10.1)                                                            BIN  163
230   FORMAT (I9,9X,A6,2H+ ,A6,8X,2H= ,A6,26X,E9.3,2X,F4.1,2X,F10.1)          BIN  164
240   FORMAT (I9,9X,A6,3H+ M,13X,2H= ,A6,2H+ ,A6,3H+ M,15X,E9.3,2X,F4.1,BIN  165
     12X,F10.1)                                                               BIN  166
250   FORMAT (I9,9X,A6,2H+ ,A6,8X,2H= ,A6,2H+ ,A6,18X,E9.3,2X,F4.1,2X,F1BIN  167
     10.1,3X,16HONE WAY REACTION)                                             BIN  168
260   FORMAT (I9,9X,A6,2H+ ,A6,3H+ M,5X,2H= ,A6,3H+ M,23X,E9.3,2X,F4.1,2BIN  169
     1X,F10.1,3X,16HONE WAY REACTION)                                         BIN  170
270   FORMAT (I9,9X,A6,2H+ ,A6,8X,2H= ,A6,2H+ ,A6,2H+ ,A6,10X,E9.3,2X,F4BIN  171
     1.1,2X,F10.1,3X,16HONE WAY REACTION)                                     BIN  172
280   FORMAT (I9,9X,A6,2H+ ,A6,8X,2H= ,A6,26X,E9.3,2X,F4.1,2X,F10.1,3X,1BIN  173
     16HONE WAY REACTION)                                                     BIN  174
290   FORMAT (I9,9X,A6,3H+ M,13X,2H= ,A6,2H+ ,A6,3H+ M,15X,E9.3,2X,F4.1,BIN  175
     12X,F10.1,3X,16HONE WAY REACTION)                                        BIN  176
300   FORMAT (1H1,37X,45HAERONAUTICAL RESEARCH ASSOCIATES OF PRINCETON)BIN  177
310   FORMAT (35X,50HAXISYMMETRIC MIXING WITH NON-EQUILIBRIUM CHEMISTRY)BIN  178
320   FORMAT (1HO,24X,19A4)                                                    BIN  179
330   FORMAT (1HO,22X,19HPRESSURE(INITIAL) =E15.7,12H ATMOSPHERES)             BIN  180
```

```
340   FORMAT (1HO,22X,20HPRESSURE(CONSTANT) =E15.7,12H ATMOSPHERES)      BIN  181
350   FORMAT (23X,24HTEMPERATURE(DEG. KELVIN),3X,E15.7,4X,E15.7)         BIN  182
360   FORMAT (23X,24HVELOCITY   (FEET/SECOND),3X,E15.7,4X,E15.7)         BIN  183
370   FORMAT (1HO,22X,14HNOZZLE RADIUS=E15.7,5H FEET,9X,17HBUOYANCY FACTBIN  184
     1OR =,E15.7)                                                       BIN  185
380   FORMAT (1HO,22X,23HLEWIS NUMBER(CONSTANT)=E15.7,5X,11HPRANDTL NUM,BIN  186
     114HBER(CONSTANT)=E15.7)                                           BIN  187
390   FORMAT (1HO,54X,3HJET,16X,4HEDGE)                                 BIN  188
400   FORMAT (23X,13HMOLE FRACTION,3X,A6,5X,E15.7,4X,E15.7)             BIN  189
410   FORMAT (1HO,22X,16HX INITIAL(FEET)=E15.7,12X,14HX FINAL(FEET)=E15.BIN  190
     17)                                                                BIN  191
420   FORMAT (1HO,22X,16HPRINT INCREMENT=E15.7,12X,17HMINIMUM STEP SIZE,BIN  192
     11H=E15.7)                                                         BIN  193
      END                                                               BIN  194
```

```
      SUBROUTINE BOATIP (RIN)                                                    BIP     1
C                                                                                BIP     2
C     INITIAL PROFILE FOR SHEAR LAYER OR BOUNDARY LAYER                          BIP     3
C                                                                                BIP     4
C      BOATCM - BOAT COMMON                                                      BIP     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),           BIP     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),              BIP     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),            BIP     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),           BIP     9
     4 RC(40,3), RHJ(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),          BIP    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),               BIP    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),         BIP    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),              BIP    13
     8 YOUT(50), ZID(5)                                                          BIP    14
C                                                                                BIP    15
      LOGICAL LHALF,LSWON                                                        BIP    16
C                                                                                BIP    17
      EQUIVALENCE (J1, J12345(1))                                                BIP    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                           BIP    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                              BIP    20
      EQUIVALENCE (CPTBV, CGHV)                                                  BIP    21
      EQUIVALENCE (HCP(1,1), WM(1))                                              BIP    22
      EQUIVALENCE (START, TTR(1))                                                BIP    23
C                                                                                BIP    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                       BIP    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BIP    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BIP    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BIP    28
     3        IDELP   ,  IFCC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BIP    29
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BIP    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BIP    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BIP    32
     7        NPSI    ,  NP    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BIP    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BIP    34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BIP    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BIP    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BIP    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BIP    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BIP    39
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BIP    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BIP    41
     7        Y       ,  ZID                                               BIP    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)            BIP    43
C                                                                          BIP    44
C     JET/EXT FLOW FIELD COMMON SECTION                                    BIP    45
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C
      COMMON  DELJ   ,  DELE   ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  BIP    46
     1        KMAXJ  ,  KMAXE  ,  NRJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BIP    47
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE   ,BIP    48
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                        BIP    49
C                                                                       BIP    50
      COMMON  ENDCM                                                     BIP    51
C                                                                       BIP    52
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BIP    53
C                                                                       BIP    54
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BIP    55
C                                                                       BIP    56
C                                                                       BIP    57
      DIMENSION RIN(50)                                                 BIP    58
      RSAV=RJ                                                           BIP    59
      IBL=0                                                             BIP    60
      PSA=PSJET                                                         BIP    61
      PSB=PSJET                                                         BIP    62
      IF (IPRESS.NE.0) GO TO 10                                         BIP    63
      UA=U(1)                                                           BIP    64
      UB=U(MPSI)                                                        BIP    65
      TA=T(1)                                                           BIP    66
      TB=T(MPSI)                                                        BIP    67
10    CONTINUE                                                          BIP    68
      IF (IPRESS.EQ.0) GO TO 40                                         BIP    69
20    CONTINUE                                                          BIP    70
      CALL BOATII (1,X,PSA,IMAXJ,KMAXJ,IJET,VJET,XJET,PSJET,RJ,P,T(1),U(BIP    71
     11),PSJET,FID,NRJET)                                               BIP    72
      CALL BOATII (2,X,PSB,IMAXE,KMAXE,IEXT,VEXT,XEXT,PSEXT,DUM,DUM,T(MPBIP    73
     1SI),U(MPSI),PSJET,FID,NREXT)                                      BIP    74
      IF (DELPSI.NE.-1) GO TO 30                                        BIP    75
      IF (IBL.EQ.1) GO TO 30                                            BIP    76
      UA=U(1)                                                           BIP    77
      UB=U(MPSI)                                                        BIP    78
      TA=T(1)                                                           BIP    79
      TB=T(MPSI)                                                        BIP    80
      PSB=PSJET*SQRT(1.+UB/UA*TA/TB*((5.6*DELE+RJ)**2/RJ**2-1.))        BIP    81
      IBL=1                                                             BIP    82
      GO TO 20                                                          BIP    83
30    CONTINUE                                                          BIP    84
40    CONTINUE                                                          BIP    85
      MPSIM1=MPSI-1                                                     BIP    86
      DO 80 I=1,MPSI,MPSIM1                                             BIP    87
      WTVR=0.                                                           BIP    88
      DO 50 J=1,NS                                                      BIP    89
                                                                        BIP    90
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```
50    WTVR=WTVR+ALPHA(J,I)*WTMOLE(J)                                    BIP   91
      DO 60 J=1,NS                                                      BIP   92
60    ALPHA(J,I)=ALPHA(J,I)/WTVR                                        BIP   93
      TX=T(I)                                                           BIP   94
      HX=0.                                                             BIP   95
      CPX=0.                                                            BIP   96
      CALL BOATTK (TX,TTP,ITKEY,SDT,HDT,NT)                             BIP   97
      IF (ITKEY.EQ.0) CALL EXIT                                         BIP   98
      DO 70 J=1,NS                                                      BIP   99
      CALL BOATLP (ITKEY,J,2,SDT,HDT,AX)                                BIP  100
      CPX=CPX+AX*45055.31*ALPHA(J,I)                                    BIP  101
      CALL BOATLP (ITKEY,J,4,SDT,HDT,AX)                                BIP  102
70    HX=HX+AX*45055.31*ALPHA(J,I)                                      BIP  103
      IF (I.EQ.1) HJ=HX                                                 BIP  104
      IF (I.EQ.MPSI) HE=HX                                              BIP  105
      IF (I.EQ.1) CPJ=CPX                                               BIP  106
      IF (I.EQ.MPSI) CPE=CPX                                            BIP  107
      IF (I.EQ.1) WMJ=WTVR                                              BIP  108
      IF (I.EQ.MPSI) WME=WTVR                                           BIP  109
80    CONTINUE                                                          BIP  110
      IF (DELPSI.EQ.-1.) GO TO 120                                      BIP  111
C     SHEAR LAYER INITIALIZATION BASED ON CUBIC PROFILE                 BIP  112
      HTJ=HJ+.5*U(1)**2                                                 BIP  113
      HTE=HE+.5*U(MPSI)**2                                              BIP  114
      DO 100 I=2,NPSI                                                   BIP  115
      RR=FLOAT(I-1)/FLOAT(NPSI)                                         BIP  116
      TERM=3.*RR**2*(1.-.667*RR)                                        BIP  117
      U(I)=U(1)+(U(MPSI)-U(1))*TERM                                     BIP  118
      DO 90 J=1,NS                                                      BIP  119
90    ALPHA(J,I)=ALPHA(J,1)+(ALPHA(J,MPSI)-ALPHA(J,1))*TERM             BIP  120
      T(I)=T(1)+(T(MPSI)-T(1))*TERM                                     BIP  121
100   CONTINUE                                                          BIP  122
      DYMIX=.27*X*(U(1)-U(MPSI))/(U(1)+U(MPSI))                         BIP  123
      DO 110 I=1,MPSI                                                   BIP  124
110   RIN(I)=FLOAT(I-1)/FLOAT(NPSI)*DYMIX+RJ-DYMIX/2.                   BIP  125
      GO TO 190                                                         BIP  126
120   CONTINUE                                                          BIP  127
      WRITE (6,230)                                                     BIP  128
C     BOUNDARY LAYER INITIALIZATION                                     BIP  129
      IF (USTJ.EQ.0.) USTJ=.0333                                        BIP  130
      IF (USTE.EQ.0.) USTE=.0333                                        BIP  131
      IPASS=0                                                           BIP  132
      DELT=DELJ+DELE                                                    BIP  133
      IGOT=DELJ/DELT*MPSI+1                                             BIP  134
C     JET SIDE BOUNDARY LAYER                                           BIP  135
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```
      WMX=WMJ                                                           BIP  136
      CPX=CPJ                                                           BIP  137
      TX=T(1)                                                           BIP  138
      UX=U(1)                                                           BIP  139
      USTAR=USTJ                                                        BIP  140
      GO TO 140                                                         BIP  141
130   CUNTINUE                                                          BIP  142
C     EXTERNAL BOUNDARY LAYER                                           BIP  143
      WMX=WME                                                           BIP  144
      CPX=CPE                                                           BIP  145
      TX=T(MPSI)                                                        BIP  146
      UX=U(MPSI)                                                        BIP  147
      USTAR=USTE                                                        BIP  148
      IPASS=1                                                           BIP  149
140   CONTINUE                                                          BIP  150
      I1=1                                                              BIP  151
      I2=IGOT                                                           BIP  152
      IF (IPASS.EQ.1) I1=IGOT+1                                         BIP  153
      IF (IPASS.EQ.1) I2=MPSI                                           BIP  154
      SS1=89517.501/WMX                                                 BIP  155
      SS2=CPX/(CPX-SS1)                                                 BIP  156
      SS=SQRT(SS2*SS1*TX)                                               BIP  157
      XMX=UX/SS                                                         BIP  158
      IF (IPASS.EQ.0) WRITE (6,240) I1,I2                               BIP  159
      IF (IPASS.EQ.1) WRITE (6,250) I1,I2                               BIP  160
      WRITE (6,270)                                                     BIP  161
      WRITE (6,260) HX,CPX,WMX,SS1,SS2,SS,XMX                           BIP  162
      DUMA=0.                                                           BIP  163
      DUMB=0.                                                           BIP  164
      WRITE (6,280)                                                     BIP  165
      DO 170 I=I1,I2                                                    BIP  166
      YX=FLOAT(I-I1)/FLOAT(I2-I1)                                       BIP  167
      IF (IPASS.EQ.0) YX=1.-YX                                          BIP  168
      IF (YX.EQ.0.) YX=.001                                             BIP  169
      RIN(I)=YX                                                         BIP  170
      UBAR=1.+USTAR*(2.5*ALOG(YX)-1.38*(1.-SIN((2.*YX-1.)*3.142/2.)))   BIP  171
      IF (RIN(I).LE..001) UBAR=0.                                       BIP  172
      T(I)=TX*(1.+(SS2-1.)/2.*XMX**2*(1.-UBAR**2))                      BIP  173
      U(I)=UBAR*UX                                                      BIP  174
      DO 150 J=1,NS                                                     BIP  175
      IX=1                                                              BIP  176
      IF (IPASS.EQ.1) IX=MPSI                                           BIP  177
      ALPHA(J,I)=ALPHA(J,IX)                                            BIP  178
150   CONTINUE                                                          BIP  179
C     DELTA CALCULATION                                                 BIP  180
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```
      TERM2=U(I)/UX*TX/T(I)                                                  BIP  181
      ATERM2=(1.-TERM2)*RIN(I)                                               BIP  182
      IF (I.EQ.I1) GO TO 160                                                 BIP  183
      TERM=(TERM1+TERM2)/2.                                                  BIP  184
      ATERM=(ATERM1+ATERM2)/2.                                               BIP  185
      TERM=1.-TERM                                                           BIP  186
      DYB=ABS(RIN(I)-RIN(I-1))                                               BIP  187
      DUMA=DUMA+ATERM*DYB                                                    BIP  188
      DUMB=DUMB+TERM*DYB                                                     BIP  189
160   CONTINUE                                                               BIP  190
      WRITE (6,260) RIN(I),U(I),T(I),TERM,UX,TX,DUMA,DUMB                    BIP  191
      ATERM1=ATERM2                                                          BIP  192
      TERM1=TERM2                                                            BIP  193
170   CONTINUE                                                               BIP  194
      IF (IPASS.EQ.0) DELSTAR=-DELJ/RJ                                       BIP  195
      IF (IPASS.EQ.1) DELSTAR=DELE/RJ                                        BIP  196
      DELBL=(-DUMB+SQRT(DUMB**2+4.*DUMA*(.5*DELSTAR**2+DELSTAR)))/2./DUMBIP  197
     1A                                                                      BIP  198
      IF (IPASS.EQ.0) DELBL=-DELBL                                           BIP  199
      DELBL=DELBL*RJ                                                         BIP  200
C     PHYSICAL Y DISTRIBUTION                                                BIP  201
      DO 180 I=I1,I2                                                         BIP  202
      IF (IPASS.EQ.0) RIN(I)=RJ-RIN(I)*DELBL                                 BIP  203
      IF (IPASS.EQ.1) RIN(I)=RJ+RIN(I)*DELBL                                 BIP  204
      IF (I.EQ.I1) WRITE (6,290)                                             BIP  205
      WRITE (6,260) RIN(I)                                                   BIP  206
180   CONTINUE                                                               BIP  207
      IF (IPASS.EQ.0) GO TO 130                                              BIP  208
190   CONTINUE                                                               BIP  209
      DO 220 I=1,MPSI                                                        BIP  210
      WTVR=0.                                                                BIP  211
      DO 200 J=1,NS                                                          BIP  212
200   WTVR=WTVR+ALPHA(J,I)                                                   BIP  213
      WTVR=1./WTVR                                                           BIP  214
      DO 210 J=1,NS                                                          BIP  215
210   ALPHA(J,I)=ALPHA(J,I)*WTVR                                             BIP  216
220   CONTINUE                                                               BIP  217
      RJ=RSAV                                                                BIP  218
      RETURN                                                                 BIP  219
C                                                                            BIP  220
230   FORMAT (1H1)                                                           BIP  221
240   FORMAT (1HO,41HJET SIDE BOUNDARY LAYER PROFILE FROM I = ,I5,4H TO BIP  222
     1,I5)                                                                   BIP  223
250   FORMAT (1HO,41HEXTERNAL BOUNDARY LAYER PROFILE FROM I = ,I5,4H TO BIP  224
     1,I5)                                                                   BIP  225
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```
260   FORMAT (8E13.5)                                                    BIP  226
270   FORMAT (1HO,T4,8HENTHALPY,T19,2HCP,T31,6HMOL WT,T42,9HGAS CONST,T5BIP  227
     17,5HGAMMA,T67,11HSOUND SPEED,T84,4HMACH,/)                         BIP  228
280   FORMAT (1HO,T6,3HRIN,T20,1HU,T33,1HT,T45,4HTERM,T59,2HUX,T71,2HTX,BIP  229
     1T84,4HDUMA,T97,4HDUMB,/)                                           BIP  230
290   FORMAT (1HO,24H PHYSICAL Y DISTRIBUTION,/)                          BIP  231
      END                                                                 BIP  232
```

```
      SUBROUTINE BOATLI(XIN,YOUT,XXX,YYY,N)                              BLI     1
      DIMENSION XXX(50),YYY(50)                                          BLI     2
      K=2                                                                BLI     3
   20 IF(XIN.LE.XXX(K)) GO TO 10                                         BLI     4
      K=K+1                                                              BLI     5
      IF(K.GT.N) WRITE(6,100)                                            BLI     6
      IF(K.GT.N) CALL EXIT                                               BLI     7
      GO TO 20                                                           BLI     8
   10 RAT=(XIN-XXX(K-1))/(XXX(K)-XXX(K-1))                               BLI     9
      YOUT=YYY(K-1)+RAT*(YYY(K)-YYY(K-1))                                BLI    10
      RETURN                                                             BLI    11
  100 FORMAT(* ......   K .GT. N  IN BOATLI   ......*)                   BLI    12
      END                                                                BLI    13
```

```
      SUBROUTINE BOATLP (ITKEY,I,IFILE,SDT,HDT,AX)                          BLP     1
C       BOATCM - BOAT COMMON                                                BLP     2
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),      BLP     3
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),         BLP     4
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),       BLP     5
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),      BLP     6
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),     BLP     7
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),          BLP     8
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),    BLP     9
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),         BLP    10
     8 YOUT(50), ZID(5)                                                     BLP    11
C                                                                           BLP    12
      LOGICAL LHALF,LSWON                                                   BLP    13
C                                                                           BLP    14
      EQUIVALENCE (J1, J12345(1))                                           BLP    15
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                      BLP    16
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                         BLP    17
      EQUIVALENCE (CPTBV, CGHV)                                             BLP    18
      EQUIVALENCE (HCP(1,1), WM(1))                                         BLP    19
      EQUIVALENCE (START, TTB(1))                                           BLP    20
C                                                                           BLP    21
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                  BLP    22
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BLP    23
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BLP    24
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BLP    25
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BLP    26
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BLP    27
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BLP    28
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BLP    29
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BLP    30
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BLP    31
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BLP    32
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BLP    33
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BLP    34
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BLP    35
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BLP    36
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BLP    37
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BLP    38
     7        Y       ,  ZID                                              BLP    39
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)             BLP    40
C                                                                           BLP    41
C     JET/EXT FLOW FIELD COMMON SECTION                                     BLP    42
C                                                                           BLP    43
      COMMON  DELJ    ,  DELE  ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  ,BLP    44
     1        KMAXJ   ,  KMAXE ,  NPJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BLP    45
```

```
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE    ,BLP    46
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                          BLP    47
                                                                          BLP    48
C                                                                         BLP    49
      COMMON  ENDCM                                                       BLP    50
C                                                                         BLP    51
C     END OF COMMON TO BE COPIED TO RESTART FILE                          BLP    52
C                                                                         BLP    53
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                             BLP    54
C                                                                         BLP    55
C                                                                         BLP    56
      DIMENSION ATB(2)                                                    BLP    57
      NREC = (I-1)*30 + ITKEY                                             BLP    58
      CALL SFVMV (CGHV(NREC,IFILE-1), ATB, 2)                             BLP    59
      AX= ATB(1)*HDT+ ATB(2)*SDT                                          BLP    60
      RETURN                                                              BLP    61
      END
```

```
      SUBROUTINE BOATLU (INIT)                                                  BLU     1
C                                                                               BLU     2
C       BOATLU - BOAT FILE LOOK UP                                              BLU     3
C                                                                               BLU     4
C       BOATCM - BOAT COMMON                                                    BLU     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),          BLU     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),             BLU     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),           BLU     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),          BLU     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),         BLU    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),              BLU    11
     6 VJET(4,25,2), WOUT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),        BLU    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),             BLU    13
     8 YOUT(50), ZID(5)                                                         BLU    14
C                                                                               BLU    15
      LOGICAL LHALF,LSWON                                                       BLU    16
C                                                                               BLU    17
      EQUIVALENCE (J1, J12345(1))                                               BLU    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                          BLU    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                             BLU    20
      EQUIVALENCE (CPTBV, CGHV)                                                 BLU    21
      EQUIVALENCE (HCP(1,1), WM(1))                                             BLU    22
      EQUIVALENCE (START, TTB(1))                                               BLU    23
C                                                                               BLU    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                      BLU    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,       BLU    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,       BLU    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,       BLU    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,       BLU    29
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,       BLU    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,       BLU    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,       BLU    32
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,       BLU    33
     8        P       ,  PCNT  ,  PPNT   ,  PRNTXC ,  PSI    ,  PSID   ,       BLU    34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,       BLU    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,       BLU    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,       BLU    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,       BLU    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,       BLU    39
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,       BLU    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,       BLU    41
     7        Y       ,  ZID                                                    BLU    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)                 BLU    43
C                                                                               BLU    44
C     JET/EXT FLOW FIELD COMMON SECTION                                         BLU    45
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C                                                                       BLU    46
      COMMON  DELJ   ,  DELE   ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  ,BLU    47
     1        KMAXJ  ,  KMAXE  ,  NRJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BLU    48
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE   ,BLU    49
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                         BLU    50
C                                                                       BLU    51
      COMMON  ENDCM                                                     BLU    52
C                                                                       BLU    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BLU    54
C                                                                       BLU    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BLU    56
C                                                                       BLU    57
C                                                                       BLU    58
C                                                                       BLU    59
C     REWIND  RESTART  FILE                                             BLU    60
C                                                                       BLU    61
      REWIND 1                                                          BLU    62
      IF (INIT.GT.0) GO TO 10                                           BLU    63
C                                                                       BLU    64
C      ZERO RPRM FILE ON START-UP                                       BLU    65
C                                                                       BLU    66
      CALL SFVFL (0.0,RPRM,30*40*2)                                     BLU    67
10    CONTINUE                                                          BLU    68
C                                                                       BLU    69
C      LOOK UP  BOAT-SPECRA OUTPUT FILE                                 BLU    70
C                                                                       BLU    71
      IF (NRAD.EQ.0) GO TO 40                                           BLU    72
C                                                                       BLU    73
C      BOAT-SPECRA FILE, FORMATTED SEQUENTIAL, POSITION AT END-OF-DATA   BLU    74
C                                                                       BLU    75
      IF (INIT.EQ.0) END FILE 2                                         BLU    76
      REWIND 2                                                          BLU    77
20    READ (2,50)                                                       BLU    78
      IF (EOF(2)) 30,20                                                 BLU    79
30    BACKSPACE 2                                                       BLU    80
      GO TO 40                                                          BLU    81
      WRITE (6,60) NAMAS                                                BLU    82
      STOP                                                              BLU    83
C                                                                       BLU    84
40    CONTINUE                                                          BLU    85
      RETURN                                                            BLU    86
C                                                                       BLU    87
50    FORMAT (40A2)                                                     BLU    88
60    FORMAT (25H  BOAT-SPECRA FILE ERROR )                             BLU    89
      END                                                               BLU    90
```

```
      SUBROUTINE BOATM1                                                 BM1     1
C                                                                       BM1     2
C     MAIN INTEGRATION CONTROL ROUTINE                                  BM1     3
C                                                                       BM1     4
C       BOATCM - BOAT COMMON                                            BM1     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),  BM1     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),     BM1     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),   BM1     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),  BM1     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50), BM1    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),      BM1    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BM1    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),     BM1    13
     8 YOUT(50), ZID(5)                                                 BM1    14
C                                                                       BM1    15
      LOGICAL LHALF,LSWON                                               BM1    16
C                                                                       BM1    17
      EQUIVALENCE (J1, J12345(1))                                       BM1    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                  BM1    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                     BM1    20
      EQUIVALENCE (CPTBV, CGHV)                                         BM1    21
      EQUIVALENCE (HCP(1,1), WM(1))                                     BM1    22
      EQUIVALENCE (START, TTB(1))                                       BM1    23
C                                                                       BM1    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV            BM1    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR ,BM1    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX    ,BM1    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT ,BM1    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2 ,BM1    29
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE ,BM1    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4    ,BM1    31
     6        J5      ,  LHALF ,  MMOO   ,  MPSI   ,  MXNPT  ,  MXNP1 ,BM1    32
     7        NPSI    ,  NP    ,  NRAD   ,  NRAS   ,  NS     ,  NT    ,BM1    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID  ,BM1    34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT,BM1    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX ,BM1    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA ,BM1    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE ,BM1    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP    ,BM1    39
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE    ,BM1    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU   ,BM1    41
     7        Y       ,  ZID                                           BM1    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)         BM1    43
C                                                                       BM1    44
C     JET/EXT FLOW FIELD COMMON SECTION                                 BM1    45
```

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C                                                                       BM1    46
      COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE  ,BM1    47
     1        KMAXJ   ,  KMAXE   ,  NPJET   ,  NREXT   ,  PSJET   ,  PSEXT  ,BM1    48
     2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE   ,BM1    49
     3        VJET    ,  VEXT    ,  XJET    ,  XEXT                         BM1    50
C                                                                       BM1    51
      COMMON  ENDCM                                                     BM1    52
C                                                                       BM1    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BM1    54
C                                                                       BM1    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BM1    56
C                                                                       BM1    57
C                                                                       BM1    58
10    CONTINUE                                                          BM1    59
      IF (IPRESS.EQ.0) GO TO 20                                         BM1    60
      CALL BOATII (1,X,PSI(1),IMAXJ,KMAXJ,IJET,VJET,XJET,PSJET,Y1,P1,DUMBM1    61
     1,DUM,PSJET,FID,NRJET)                                             BM1    62
      CALL BOATII (2,X,PSI(MPSI),IMAXE,KMAXE,IEXT,VEXT,XEXT,PSEXT,Y2,P2,BM1    63
     1DUM,DUM,PSJET,FID,NREXT)                                          BM1    64
20    CONTINUE                                                          BM1    65
      DO 50 I=1,MPSI                                                    BM1    66
      WTMIX(I)=0.0                                                      BM1    67
      DO 30 J=1,NS                                                      BM1    68
30    WTMIX(I)=WTMIX(I)+ALPHA(J,I)                                      BM1    69
      IF (IPRESS.EQ.0) GO TO 40                                         BM1    70
      IF (PSI(I).LT.PSJET) CALL BOATII (1,X,PSI(I),IMAXJ,KMAXJ,IJET,VJETBM1    71
     1,XJET,PSJET,DUM,P,DUM,DUM,PSJET,FID,NRJET)                        BM1    72
      IF (PSI(I).GE.PSJET) CALL BOATII (2,X,PSI(I),IMAXE,KMAXE,IEXT,VEXTBM1    73
     1,XEXT,PSEXT,DUM,P,DUM,DUM,PSJET,FID,NREXT)                        BM1    74
40    CONTINUE                                                          BM1    75
      RHO(I)=P/89517.501/T(I)/WTMIX(I)                                  BM1    76
50    RHOOUT(I)=RHO(I)/1.94                                             BM1    77
      DO 70 I=1,MPSI                                                    BM1    78
C                                                                       BM1    79
C     FREE STREAM VELOCITY WILL BE SET TO 1.0 FPS IF ZERO IS ENTERED    BM1    80
C                                                                       BM1    81
      U(I)=AMAX1(1.0,U(I))                                              BM1    82
      CPBAR(I)=0.0                                                      BM1    83
      HSTAT(I)=0.0                                                      BM1    84
      TX=T(I)                                                           BM1    85
      CALL BOATTK (TX,TTB,ITKEY,SDT,HDT,NT)                             BM1    86
      IF (ITKEY.EQ.0) GO TO 250                                         BM1    87
      DO 60 J=1,NS                                                      BM1    88
      CALL BOATLP (ITKEY,J,2,SDT,HDT,AX)                                BM1    89
      HCP(2,J)=AX*45055.31                                              BM1    90
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      CALL BOATLP (ITKEY,J,4,SDT,HDT,AX)                                BM1   91
      HCP(1,J)=AX*45055.31                                              BM1   92
      HSTAT(I)=HSTAT(I)+HCP(1,J)*ALPHA(J,I)                             BM1   93
60    CPBAR(I)=CPBAR(I)+HCP(2,J)*ALPHA(J,I)                             BM1   94
70    CONTINUE                                                          BM1   95
      IF (IPRESS.EQ.0) Y(1)=PSI(1)/SQRT(RHO(1)*U(1))                    BM1   96
      IF (IPRESS.NE.0) Y(1)=Y1                                          BM1   97
      YTOP=Y(MPSI)                                                      BM1   98
      DO 80 I=2,MPSI                                                    BM1   99
      DUM=(RHO(I)*U(I)+RHO(I-1)*U(I-1))/2                               BM1  100
80    Y(I)=SQRT(Y(I-1)**2+(PSI(I)**2-PSI(I-1)**2)/DUM)                  BM1  101
      IF (YTOP.EQ.0.) GO TO 90                                          BM1  102
      XK2=(Y(MPSI)-YTOP)/DX                                             BM1  103
90    CONTINUE                                                          BM1  104
C                                                                       BM1  105
C     KE2 INITIALIZATION                                                BM1  106
C                                                                       BM1  107
      IF (IVIS.GE.0) GO TO 150                                          BM1  108
      IF (X.GT.XINIT) GO TO 150                                         BM1  109
      IF (IVIS.EQ.-2) GO TO 110                                         BM1  110
C     XK NOT SPECIFIED, IVIS=-1                                         BM1  111
      IVIS=0                                                            BM1  112
      CALL BOATVI                                                       BM1  113
      XK(1)=0.                                                          BM1  114
      XK(MPSI)=0.                                                       BM1  115
      XE(1)=0.                                                          BM1  116
      XE(MPSI)=0.                                                       BM1  117
      DO 100 I=2,NPSI                                                   BM1  118
      XK(I)=XMU(I)*(U(I+1)-U(I-1))/2./DELPSI*U(I)*Y(I)/.3/PSI(I)        BM1  119
      XK(I)=ABS(XK(I))                                                  BM1  120
100   CONTINUE                                                          BM1  121
      IVIS=-1                                                           BM1  122
      GO TO 130                                                         BM1  123
110   CONTINUE                                                          BM1  124
C     XK SPECIFIED, IVIS=-2                                             BM1  125
      XMU(1)=0.                                                         BM1  126
      XMU(MPSI)=0.                                                      BM1  127
      DO 120 I=2,NPSI                                                   BM1  128
      XMU(I)=.3*XK(I)*PSI(I)*2.*DELPSI/U(I)/Y(I)/(U(I+1)-U(I-1))        BM1  129
      XMU(I)=ABS(XMU(I))                                                BM1  130
120   CONTINUE                                                          BM1  131
130   CONTINUE                                                          BM1  132
      DO 140 I=2,NPSI                                                   BM1  133
      XE(I)=.09*RHO(I)*XK(I)**2/XMU(I)                                  BM1  134
      RXK(I)=XK(I)                                                      BM1  135
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      RXE(I)=XE(I)                                                      BM1  136
140   CONTINUE                                                          BM1  137
      RXK(1)=0.                                                         BM1  138
      RXE(1)=0.                                                         BM1  139
      RXK(MPSI)=0.                                                      BM1  140
      RXE(MPSI)=0.                                                      BM1  141
150   CONTINUE                                                          BM1  142
      CALL BOATVI                                                       BM1  143
C                                                                       BM1  144
C       CHECK DIFFUSION STEP SIZE                                       BM1  145
C                                                                       BM1  146
      XD=(Y(MPSI)-Y(1))/FLOAT(MPSI)                                     BM1  147
      DO 160 I=2,NPSI                                                   BM1  148
      DUMMY=2.*(Y(I+1)-Y(I-1))                                          BM1  149
160   XD=AMIN1(XD,DUMMY)                                                BM1  150
      FDL=FDL+DFDL                                                      BM1  151
      IF (FDL.GT.1..OR.FDL.LT..01) FDL=1.                               BM1  152
      XD=XD*FDL                                                         BM1  153
C                                                                       BM1  154
      DO 170 I=2,NPSI                                                   BM1  155
      DUMMY=A(I+1)+A(I-1)+A(I)+A(I)                                     BM1  156
      DUMMY=DUMMY/2.                                                    BM1  157
      DUMMY=PSI(I)*DELPSI*DELPSI*SIGMA(I)/XLE(I)/DUMMY/1.5              BM1  158
170   XD=AMIN1(XD,DUMMY)                                                BM1  159
      DX=AMIN1(DX,XD)                                                   BM1  160
      IF (IPRESS.EQ.0) GO TO 180                                        BM1  161
      XDUM=X+DX                                                         BM1  162
      CALL BOATII (1,XDUM,PSI(1),IMAXJ,KMAXJ,IJET,VJET,XJET,PSJET,DUM,P3BM1  163
     1,RT(1),RU(1),PSJET,FID,NRJET)                                     BM1  164
      CALL BOATII (2,XDUM,PSI(MPSI),IMAXE,KMAXE,IEXT,VEXT,XEXT,PSEXT,DUMBM1  165
     1,P4,RT(MPSI),RU(MPSI),PSJET,FID,NREXT)                            BM1  166
180   CONTINUE                                                          BM1  167
C                                                                       BM1  168
      CALL BOATS2                                                       BM1  169
C                                                                       BM1  170
      IOUT=IOUT+1                                                       BM1  171
      IF (IFINIS) 190,230,190                                           BM1  172
190   IF (X-XMAX) 200,220,220                                           BM1  173
200   IF (PRNT-PCNT) 230,230,210                                        BM1  174
210   CONTINUE                                                          BM1  175
      GO TO 240                                                         BM1  176
220   IFINIS=2                                                          BM1  177
      XMAX=2.0*XMAX                                                     BM1  178
230   CALL BOATUT                                                       BM1  179
      IF (PSID.NE.0.) WRITE (6,260)                                     BM1  180
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```
      PCNT=0.0                                                          BM1  181
240   CONTINUE                                                          BM1  182
      ISFIN=IFINIS                                                      BM1  183
         (LSWON(4)) WRITE (6,270) DX,X                                  BM1  184
C                                                                       BM1  185
      CALL BOATM2                                                       BM1  186
C                                                                       BM1  187
C     CHECK FOR SWO OR MAX TIME EXCEEDED HERE                           BM1  188
C                                                                       BM1  189
      ITFLG=0                                                           BM1  190
      IF (LSWON(1)) ITFLG=1                                             BM1  191
      TIME=ETIME(TSTRT)                                                 BM1  192
      IF (TIME.LT.RTJAC) TIME=TIME+24.*60.                              BM1  193
      TJAC=TIME-RTJAC                                                   BM1  194
      IF (TJAC.GE.RTJOB) ITFLG=2                                        BM1  195
      IF (ISFIN.EQ.2) ITFLG=5                                           BM1  196
      IF (ITFLG.GT.0) CALL BOATCP                                       BM1  197
      GO TO 10                                                          BM1  198
250   STOP                                                              BM1  199
C                                                                       BM1  200
260   FORMAT (1HO,T4,4HXBAR,T14,4HPSID,T23,6HPSI(X),T32,9H  Y(MPSI),T44,BM1  201
     15HSLOPE,T55,3HV/U,T62,7HDEL*(X),T71,10HDEL*(X-DX),T84,4HRDIV,T94,4BM1  202
     2HREFF,/)                                                          BM1  203
270   FORMAT (1H ,2E12.5)                                               BM1  204
      END                                                               BM1  205
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```
      SUBROUTINE BOATM2                                                      BM2     1
C                                                                            BM2     2
C     RESET DEPENDENT VARIABLES AFTER INTEGRATION STEP                       BM2     3
C                                                                            BM2     4
C       BOATCM - BOAT COMMON                                                 BM2     5
      DIMENSION A(50), AID(2,1), ALOC(50,6), ALPHA(25,50), CGHV(750,3),      BM2     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),          BM2     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),        BM2     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),       BM2     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),      BM2    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),           BM2    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),     BM2    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),          BM2    13
     8 YOUT(50), ZID(5)                                                      BM2    14
C                                                                            BM2    15
      LOGICAL LHALF,LSWON                                                    BM2    16
C                                                                            BM2    17
      EQUIVALENCE (J1, J12345(1))                                            BM2    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                       BM2    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                          BM2    20
      EQUIVALENCE (CPTBV, CGHV)                                              BM2    21
      EQUIVALENCE (HCP(1,1), WM(1))                                          BM2    22
      EQUIVALENCE (START, TTB(1))                                            BM2    23
C                                                                            BM2    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                   BM2    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BM2    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BM2    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BM2    28
     3        IDELP   ,  IFCC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BM2    29
     4        IPAGE   ,  IPRESS ,  IRR   ,  IRRR   ,  IRT    ,  ISAVE  ,BM2    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BM2    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BM2    32
     7        NPSI    ,  NP    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BM2    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BM2    34
     9        QX      ,  RALPHA ,  RBUOY ,  RC     ,  RHO    ,  RHOOUT ,BM2    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BM2    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BM2    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BM2    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BM2    39
     5        WTMIX   ,  WTMOLE ,  X     ,  XCHANG ,  XD     ,  XE     ,BM2    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BM2    41
     7        Y       ,  ZID                                              BM2    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)            BM2    43
C                                                                            BM2    44
C     JET/EXT FLOW FIELD COMMON SECTION                                      BM2    45
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C                                                                       BM2    46
      COMMON  DELJ   ,  DELE   ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  ,BM2    47
     1        KMAXJ  ,  KMAXE  ,  NPJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BM2    48
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE   ,BM2    49
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                         BM2    50
C                                                                       BM2    51
      COMMON  ENDCM                                                     BM2    52
C                                                                       BM2    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BM2    54
C                                                                       BM2    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BM2    56
C                                                                       BM2    57
C                                                                       BM2    58
      IFINIS=1                                                          BM2    59
      NTEST=MPSI-1                                                      BM2    60
C                                                                       BM2    61
C      CHECK NEGATIVE MOLE FRACTION                                     BM2    62
C                                                                       BM2    63
      NDUM=2                                                            BM2    64
      IF (PSI(1).EQ.0.) NDUM=1                                          BM2    65
      DO 10 I=NDUM,NTEST                                                BM2    66
      IF (ABS(T(I)-RT(I)).GT.TCONT) GO TO 100                           BM2    67
      DO 10 J=1,NS                                                      BM2    68
      IF (PALPHA(J,I)) 110,10,10                                        BM2    69
10    CONTINUE                                                          BM2    70
      X=X+DX                                                            BM2    71
      PCNT=PCNT+DX                                                      BM2    72
      DX=XD                                                             BM2    73
      CALL BOATEN (PSII,PSIE)                                           BM2    74
      IF (PSID.NE.0.) CALL BOATDS (PSIE)                                BM2    75
      K=2                                                               BM2    76
      DELTSI=(PSIE-PSII)/FLOAT(NPSI)                                    BM2    77
      DO 60 I=2,NPSI                                                    BM2    78
      PSIT=PSII+FLOAT(I-1)*DELTSI                                       BM2    79
20    IF (PSIT.LE.PSI(K)) GO TO 30                                      BM2    80
      K=K+1                                                             BM2    81
      GO TO 20                                                          BM2    82
30    RAT=(PSIT-PSI(K-1))/DELPSI                                        BM2    83
      U(I)=RU(K-1)+RAT*(RU(K)-RU(K-1))                                  BM2    84
      T(I)=RT(K-1)+RAT*(RT(K)-RT(K-1))                                  BM2    85
C                                                                       BM2    86
      IF (IVIS.GE.0) GO TO 40                                           BM2    87
      XK(I)=RXK(K-1)+RAT*(RXK(K)-RXK(K-1))                              BM2    88
      XE(I)=RXE(K-1)+RAT*(RXE(K)-RXE(K-1))                              BM2    89
      IF (I.EQ.2) RATSI=(PSIT-PSI(1))/DELPSI                            BM2    90
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      IF (I.EQ.2) XK(2)=RXK(2)*RATSI**2                                  BM2   91
      IF (I.EQ.2) XE(2)=RXE(2)*RATSI**2                                  BM2   92
      IF (I.EQ.NPSI) RATSI=(PSIT-PSI(MPSI))/DELPSI                       BM2   93
      IF (I.EQ.2) XK(NPSI)=RXK(NPSI)*RATSI**2                            BM2   94
      IF (I.EQ.2) XE(NPSI)=RXE(NPSI)*RATSI**2                            BM2   95
40    CONTINUE                                                           BM2   96
C                                                                        BM2   97
      DO 50 J=1,NS                                                       BM2   98
50    ALPHA(J,I)=RALPHA(J,K-1)+RAT*(RALPHA(J,K)-RALPHA(J,K-1))           BM2   99
60    CONTINUE                                                           BM2  100
      MPSIM1=MPSI-1                                                      BM2  101
      DO 80 I=1,MPSI,MPSIM1                                              BM2  102
      U(I)=RU(I)                                                         BM2  103
      T(I)=RT(I)                                                         BM2  104
      DO 70 J=1,NS                                                       BM2  105
70    ALPHA(J,I)=RALPHA(J,I)                                             BM2  106
C                                                                        BM2  107
      IF (IVIS.GE.0) GO TO 80                                            BM2  108
      XK(I)=RXK(I)                                                       BM2  109
      XE(I)=RXE(I)                                                       BM2  110
C                                                                        BM2  111
80    CONTINUE                                                           BM2  112
      DELPSI=DELTSI                                                      BM2  113
      DO 90 I=1,MPSI                                                     BM2  114
90    PSI(I)=PSIT+FLOAT(I-1)*DELPSI                                      BM2  115
      GO TO 140                                                          BM2  116
100   CONTINUE                                                           BM2  117
      WRITE (6,150) I,T(I),RT(I)                                         BM2  118
      GO TO 120                                                          BM2  119
110   CONTINUE                                                           BM2  120
      IF (LSWON(4)) WRITE (6,160) J,I,RALPHA(J,I)                        BM2  121
120   IF (DX.LT.DXMIN) GO TO 130                                         BM2  122
      DX=DX/2.0                                                          BM2  123
      GO TO 140                                                          BM2  124
130   WRITE (6,170)                                                      BM2  125
      CALL EXIT                                                          BM2  126
140   RETURN                                                             BM2  127
C                                                                        BM2  128
150   FORMAT (32H TEMPERATURE CHANGE TOO BIG, I =,I3,5X,6HT(I) =,E12.5,5BM2  129
     1X,7HRT(I) =,E12.5)
160   FORMAT (22H NEGATIVE SPECIES, I =,I3,5X,3HJ =,I3,5X,13HRALPHA(J,I)BM2  130
     1 =,E12.5)                                                          BM2  131
170   FORMAT (56H1NEGATIVE PARAMETER - NOT CORRECTED BY REPEATED HALVINGBM2  132
     1 ,12HOF STEP SIZE)                                                 BM2  133
      END                                                                BM2  134
                                                                         BM2  135
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      SUBROUTINE BOATOT                                                  BOT     1
C                                                                        BOT     2
C     OUTPUT ROUTINE                                                     BOT     3
C                                                                        BOT     4
C                                                                        BOT     5
C       BOATCM - BOAT COMMON                                             BOT     6
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),   BOT     7
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),      BOT     8
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),    BOT     9
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),   BOT    10
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),  BOT    11
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),       BOT    12
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BOT    13
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),      BOT    14
     8 YOUT(50), ZID(5)                                                  BOT    15
C                                                                        BOT    16
      LOGICAL LHALF,LSWON                                                BOT    17
C                                                                        BOT    18
      EQUIVALENCE (J1, J12345(1))                                        BOT    19
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                   BOT    20
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                      BOT    21
      EQUIVALENCE (CPTBV, CGHV)                                          BOT    22
      EQUIVALENCE (HCP(1,1), WM(1))                                      BOT    23
      EQUIVALENCE (START, TTB(1))                                        BOT    24
C                                                                        BOT    25
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                BOT    26
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BOT    27
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BOT    28
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BOT    29
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BOT    30
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BOT    31
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BOT    32
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BOT    33
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BOT    34
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BOT    35
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BOT    36
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BOT    37
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BOT    38
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BOT    39
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BOT    40
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BOT    41
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BOT    42
     7        Y       ,  ZID                                            BOT    43
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)          BOT    44
C                                                                        BOT    45
C     JET/EXT FLOW FIELD COMMON SECTION
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C
      COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE   ,BOT    46
     1        XMAXJ   ,  XMAXE   ,  NRJET   ,  NREXT   ,  PSJET   ,  PSEXT   ,BOT    47
     2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE    ,BOT    48
     3        VJET    ,  VEXT    ,  XJET    ,  XEAT                          ,BOT    49
C                                                                             BOT    50
      COMMON  ENDCM                                                           BOT    51
C                                                                             BOT    52
C     END OF COMMON TO BE COPIED TO RESTART FILE                              BOT    53
C                                                                             BOT    54
      COMMON  FID(3,5),  IFNAM(3),  LSWUN(16)                                 BOT    55
C                                                                             BOT    56
C                                                                             BOT    57
      DIMENSION RPRMV(10), DATA(7)                                            BOT    58
      DATA ZCO/4HCO  /                                                        BOT    59
      DATA ZCO2/4HCO2 /                                                       BOT    60
      DATA ZH2O/4HH2O /                                                       BOT    61
      DATA ZN2/4HN2  /                                                        BOT    62
      CALL DATE (RDATE)                                                       BOT    63
      DO 10 I=1,NS                                                            BOT    64
      IF (AID(I).EQ.ZCO) ICO=I                                                BOT    65
      IF (AID(I).EQ.ZCO2) ICO2=I                                              BOT    66
      IF (AID(I).EQ.ZH2O) IH2O=I                                              BOT    67
      IF (AID(I).EQ.ZN2) IN2=I                                                BOT    68
10    CONTINUE                                                                BOT    69
      IF (X.GE.XCHANG) PRNT=PRNTXC                                            BOT    70
      DO 20 I=1,MPSI                                                          BOT    71
20    YOUT(I)=Y(I)/RJ                                                         BOT    72
      PCNT=0.0                                                                BOT    73
      IPAGE=IPAGE+1                                                           BOT    74
      WRITE (6,260) X,(TITLE(I),I=1,18),IPAGE,RDATE                           BOT    75
      WRITE (6,220)                                                           BOT    76
      XORJ=X/RJ                                                               BOT    77
      POUT=P/2117.0                                                           BOT    78
      WRITE (6,230) XORJ,DX,POUT                                              BOT    79
      WRITE (6,240)                                                           BOT    80
      WRITE (6,370)                                                           BOT    81
      DO 30 I=1,MPSI                                                          BOT    82
      SS1=89517.501*WTMIX(I)                                                  BOT    83
      SS2=CPBAR(I)/(CPBAR(I)-SS1)                                             BOT    84
      SS=SQRT(SS2*SS1*T(I))                                                   BOT    85
      XMACH=U(I)/SS                                                           BOT    86
      XMUOUT=XMU(I)*32.174                                                    BOT    87
      HOUT=HSTAT(I)/45055.31                                                  BOT    88
      IF (IVIS.LT.0) HOUT=XK(I)                                               BOT    89
                                                                              BOT    90
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```
     * RATP=FLOAT(I-1)/FLOAT(MPSI-1)                                          BOT   91
       RATP=FLOAT(I-1)/FLOAT(MPSI-1)                                          BOT   92
       PRESS=P1+RATP*(P2-P1)                                                  BOT   93
       PRESS=PRESS/2117.0                                                     BOT   94
       IF (IPRESS.EQ.0) PRESS=POUT                                            BOT   95
       IF (IVIS.LT.0) PRESS=XF(I)                                             BOT   96
       WRITE (6,290) I,YOUT(I),U(I),T(I),RHOOUT(I),XMACH,HOUT,XMUOUT,PSI(BOT   97
      1I),PRESS                                                               BOT   98
30     CONTINUE                                                               BOT   99
       IRPT=(NS+6)/7                                                          BOT  100
       DO 80 KK=1,IRPT                                                        BOT  101
       I1=1+(KK-1)*7                                                          BOT  102
       I2=7+(KK-1)*7                                                          BOT  103
       WRITE (6,260) X,(TITLE(I),I=1,18),IPAGE,RDATE                          BOT  104
       WRITE (6,300)                                                          BOT  105
       WRITE (6,250) (AID(J),J=I1,I2)                                         BOT  106
       DO 50 I=1,MPSI                                                         BOT  107
       DO 40 II=I1,I2                                                         BOT  108
       JJ=II-I1+1                                                             BOT  109
       RPRMV(JJ)=BOATAW(II,I)                                                 BOT  110
40     CONTINUE                                                               BOT  111
       JJ=I2-I1+1                                                             BOT  112
50     WRITE (6,270) I,YOUT(I),(RPRMV(J),J=1,JJ)                              BOT  113
       IF (IOUT1) 80,80,60                                                    BOT  114
60     WRITE (6,310)                                                          BOT  115
       WRITE (6,320) (AID(J),J=I1,I2)                                         BOT  116
       DO 70 I=1,MPSI                                                         BOT  117
       IF (T(I)-TKINET) 80,80,70                                              BOT  118
70     WRITE (6,330) I,(WDOT(J,I),J=I1,I2),I                                  BOT  119
80     CONTINUE                                                               BOT  120
C                                                                             BOT  121
C      OUTPUT FOR SPECRA PROGRAM                                              BOT  122
C                                                                             BOT  123
       IF (NRAD.EQ.0) GO TO 100                                               BOT  124
C                                                                             BOT  125
       DATA (3)=POUT*2117.                                                    BOT  126
       ZRAD=X*12.0                                                            BOT  127
       WRITE (2,200) ZRAD,MPSI                                                BOT  128
C                                                                             BOT  129
       DO 90 I=1,MPSI                                                         BOT  130
       DATA (1)=Y(I)*12.0                                                     BOT  131
       DATA (2)=T(I)*1.8                                                      BOT  132
       DATA (4)=BOATAW(IH2O,I)                                                BOT  133
       DATA (5)=BOATAW(ICO2,I)                                                BOT  134
       DATA (6)=BOATAW(ICO,I)                                                 BOT  135
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      DATA (7)=CARB*(.76973-RALPHA(IN2,I))                                  BOT  136
      WRITE (2,210) DATA                                                    BOT  137
90    CONTINUE                                                              BOT  138
100   CONTINUE                                                              BOT  139
C                                                                           BOT  140
      IF (IOUT2) 190,190,110                                                BOT  141
110   IRPT=(NR+9)/10                                                        BOT  142
      N=0                                                                   BOT  143
      NNR=NR-1                                                              BOT  144
      DO 180 KK=1,IRPT                                                      BOT  145
      LL=0                                                                  BOT  146
      N=N+1                                                                 BOT  147
      WRITE (6,260) X,(TITLE(I),I=1,18),IPAGE,RDATE                         BOT  148
120   I1=1+(N-1)*5                                                          BOT  149
      I2=5+(N-1)*5                                                          BOT  150
      NNN1=I1                                                               BOT  151
      NNN2=I1+1                                                             BOT  152
      NNN3=I1+2                                                             BOT  153
      NNN4=I1+3                                                             BOT  154
      NNN5=I2                                                               BOT  155
      WRITE (6,280)                                                         BOT  156
      WRITE (6,340) NNN1,NNN2,NNN3,NNN4,NNN5                                BOT  157
      WRITE (6,350)                                                         BOT  158
      DO 140 I=1,MPSI                                                       BOT  159
      IF (T(I)-TKINET) 150,150,130                                          BOT  160
130   NREC=(I-1)*25+I1                                                      BOT  161
      CALL SFVMV (RPRM(NREC),RPRMV,10)                                      BOT  162
140   WRITE (6,360) I,YOUT(I),RPRMV,I                                       BOT  163
150   IF (NNR/(5*N)) 180,180,160                                            BOT  164
160   IF (LL) 180,170,180                                                   BOT  165
170   N=N+1                                                                 BOT  166
      LL=1                                                                  BOT  167
      GO TO 120                                                             BOT  168
180   CONTINUE                                                              BOT  169
190   CONTINUE                                                              BOT  170
      RETURN                                                                BOT  171
C                                                                           BOT  172
200   FORMAT (E10.3,I10,60X)                                                BOT  173
210   FORMAT (7E10.3,10X)                                                   BOT  174
220   FORMAT (1HO,8X,3HX/R,8X,8HDELTA X ,4HFEET,4X,10HPRESS(ATM))           BOT  175
230   FORMAT (4X,6E14.6)                                                    BOT  176
240   FORMAT (4HO PT,5X,3HY/R,6X,8HVELOCITY,4X,11HTEMPERATURE,5X,5HDENSI    BOT  177
     1,2HTY,7X,8HMACH NO.,5X,8HENTH-TKE,5X,9HVISCOSITY,9X,3HPSI,10X,5HPR   BOT  178
     2-XE)                                                                  BOT  179
250   FORMAT (3HOPT,3X,5H Y/R ,7(3X,A4,6X),1X,3H PT)                        BOT  180
```

```
260    FORMAT (1H1,//////3H X=E15.7,5H FEET,8X,18A4,8X,4HPAGE I4,2X,A10)   BOT  181
270    FORMAT (I3,F9.5,7E13.5)                                             BOT  182
280    FORMAT (1H ,//40X,28HREACTION RATES (MOLE/ML-SEC)//)                BOT  183
290    FORMAT (I4,F10.4,8E14.6)                                            BOT  184
300    FORMAT (1HO,44X,14HMOLE FRACTIONS)                                  BOT  185
310    FORMAT (1HO,35X,36HNET RATE OF PRODUCTION (W-DOT/RHO*U))            BOT  186
320    FORMAT (3HOPT,8X,7(3X,A4,6X))                                       BOT  187
330    FORMAT (I3,9X,7E13.5,I3)                                            BOT  188
340    FORMAT (1HO,2HPT,4X,3HY/P,8X,5(8HREACTION,I3,11X),2HPT)             BOT  189
350    FORMAT (9X,5(10X,2HPP,9X,2HRM))                                     BOT  190
360    FORMAT (I3,1X,11E11.4,I4)                                           BOT  191
370    FORMAT (18X,8HFEET/SEC,4X,11H      K      ,6X,5HGM/CC,24X,6HCAL/GM,6BOT  192
      1X,9HLB/FT/SEC)                                                      BOT  193
       END                                                                 BOT  194
```

```
      SUBROUTINE BOATRS (XTMAX,XTJOB)                                                    BRS     1
C                                                                                        BRS     2
C       BOATRS - RESTART ENTRY POINT                                                     BRS     3
C                                                                                        BRS     4
C       BOATCM - BOAT COMMON                                                             BRS     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),                   BRS     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),                      BRS     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),                    BRS     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),                   BRS     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),                  BRS    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),                       BRS    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),                 BRS    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),                      BRS    13
     8 YOUT(50), ZID(5)                                                                  BRS    14
C                                                                                        BRS    15
      LOGICAL LHALF    ,NON                                                            BRS    16
C                                                                                        BRS    17
      EQUIVALENCE (J1, J12345(1))                                                        BRS    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                                   BRS    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                                      BRS    20
      EQUIVALENCE (CPTBV, CGHV)                                                          BRS    21
      EQUIVALENCE (HCP(1,1), WM(1))                                                      BRS    22
      EQUIVALENCE (START, TTB(1))                                                        BRS    23
C                                                                                        BRS    24
      COMMON   TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                            BRS    25
      COMMON   A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BRS    26
     1         CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BRS    27
     2         DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BRS    28
     3         IDELP   ,  IFCC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BRS    29
     4         IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BRS    30
     5         ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BRS    31
     6         J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BRS    32
     7         NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BRS    33
     8         P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BRS    34
     9         QX      ,  RALPHA,  RBUUY  ,  RC     ,  RHO    ,  RHOOUT ,BRS    35
     1         RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BRS    36
     2         RU      ,  RXF   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BRS    37
     3         T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BRS    38
     4         TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BRS    39
     5         WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BRS    40
     6         XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BRS    41
     7         Y       ,  ZID                                                          BRS    42
      COMMON   FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)                       BRS    43
C                                                                                        BRS    44
C     JET/EXT FLOW FIELD COMMON SECTION                                                  BRS    45
```

```
C                                                                       BRS    46
      COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE  ,BRS    47
     1        KMAXJ   ,  KMAXE   ,  NPJET   ,  NREXT   ,  PSJET   ,  PSEXT  ,BRS    48
     2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE   ,BRS    49
     3        VJET    ,  VEXT    ,  XJET    ,  XEXT                         BRS    50
C                                                                       BRS    51
      COMMON  ENDCM                                                     BRS    52
C                                                                       BRS    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BRS    54
C                                                                       BRS    55
      COMMON  FID(3,5),  IFNAM(3),  LSWUN(16)                           BRS    56
C                                                                       BRS    57
C                                                                       BRS    58
      TMAX=XTMAX                                                        BRS    59
      TJOB=XTJOB                                                        BRS    60
      CALL DATE (RDATE)                                                 BRS    61
C                                                                       BRS    62
C      LOOK UP FILES AND READ IN COMMON                                 BRS    63
C                                                                       BRS    64
      CALL BOATLU (1)                                                   BRS    65
      NWCM=NFWAB(START,ENDCM)+1                                         BRS    66
      READ (1) (START(I),I=1,NWCM)                                      BRS    67
C                                                                       BRS    68
      WRITE (6,10) TITLE,RDATE,IFNAM,NAMAS                              BRS    69
C                                                                       BRS    70
C     GET TIME PARAMETERS                                               BRS    71
C                                                                       BRS    72
      IF (TMAX.GT.0.0) RTMAX=RTMAX+TMAX                                 BRS    73
      IF (TJOB.GT.0.0) RTJOB=TJOB                                       BRS    74
      IF (TJOB.EQ.0.0) RTJOB=RTMAX-RTACU                                BRS    75
      RTJAC=0.0                                                         BRS    76
      WRITE (6,20) RTMAX,RTACU,RTJOB,RTJAC                              BRS    77
      RETURN                                                            BRS    78
C                                                                       BRS    79
10    FORMAT (1H1,23H RESTART OF BOAT RUN - ,18A4,5X,A10//16H RESTART FIBRS    80
     1LE - ,3A2,21H, BOAT-SPECRA FILE - ,3A2/)                          BRS    81
20    FORMAT (/15H MAX RUN TIME =,F8.2,5X,22HACCUMULATED RUN TIME =,F8.2BRS    82
     1/15H MAX JOB TIME =,F8.2,5X,22HACCUMULATED JOB TIME =,F8.2//)     BRS    83
      END                                                               BRS    84
```

```
      SUBROUTINE BOATSL (X,A,N)                                          BSL     1
C     THIS PROGRAM FINDS THE SOLUTIONS TO A SET OF N SIMULTANEOUS LINEARBSL     2
C     EQUATIONS BY USING THE GAUSS-GORDAN REDUCTION ALGORITHM WITH THE   BSL     3
C      DIAGONAL PIVOT STRATEGY                                           BSL     4
      DIMENSION A(25,25), X(25)                                          BSL     5
      DO 40 K=1,N                                                        BSL     6
      IF (ABS(A(K,K)).GT.1.E-10) GO TO 10                                BSL     7
      WRITE (6,60)                                                       BSL     8
      GO TO 50                                                           BSL     9
10    KP1=K+1                                                            BSL    10
      DO 20 J=KP1,N                                                      BSL    11
20    A(K,J)=A(K,J)/A(K,K)                                               BSL    12
      X(K)=X(K)/A(K,K)                                                   BSL    13
      A(K,K)=1.0                                                         BSL    14
      DO 40 I=1,N                                                        BSL    15
      IF (I.EQ.K.OR.A(I,K).EQ.0.) GO TO 40                               BSL    16
      DO 30 J=KP1,N                                                      BSL    17
30    A(I,J)=A(I,J)-A(I,K)*A(K,J)                                        BSL    18
      X(I)=X(I)-A(I,K)*X(K)                                              BSL    19
      A(I,K)=0.                                                          BSL    20
40    CONTINUE                                                           BSL    21
50    CONTINUE                                                           BSL    22
      RETURN                                                             BSL    23
C                                                                        BSL    24
60    FORMAT (22H ERROR--- SMALL PIVOT )                                 BSL    25
      END                                                                BSL    26
```

```
      SUBROUTINE BOATS1                                                 BS1     1
C                                                                       BS1     2
C       BOATS1 - BOAT INPUT ROUTINE                                     BS1     3
C                                                                       BS1     4
      LOGICAL LRSI                                                      BS1     5
C       BOATCM - BOAT COMMON                                            BS1     6
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),  BS1     7
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),     BS1     8
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),   BS1     9
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),  BS1    10
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50), BS1    11
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),      BS1    12
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BS1    13
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),     BS1    14
     8 YCUT(50), ZID(5)                                                 BS1    15
C                                                                       BS1    16
      LOGICAL LHALF,LSWOM                                               BS1    17
C                                                                       BS1    18
      EQUIVALENCE (J1, J12345(1))                                       BS1    19
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                  BS1    20
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                     BS1    21
      EQUIVALENCE (CPTBV, CGHV)                                         BS1    22
      EQUIVALENCE (HCP(1,1), WM(1))                                     BS1    23
      EQUIVALENCE (START, TTB(1))                                       BS1    24
C                                                                       BS1    25
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV              BS1    26
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BS1    27
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BS1    28
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BS1    29
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BS1    30
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BS1    31
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BS1    32
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BS1    33
     7        NPSI    ,  NP    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BS1    34
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BS1    35
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BS1    36
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BS1    37
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BS1    38
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BS1    39
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BS1    40
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BS1    41
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BS1    42
     7        Y       ,  ZID                                           BS1    43
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)         BS1    44
C                                                                       BS1    45
```

```
C      JET/EXT FLOW FIELD COMMON SECTION                                    BS1    46
C                                                                           BS1    47
       COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE  ,BS1    48
      1        KMAXJ   ,  KMAXE   ,  NRJET   ,  NREXT   ,  PSJET   ,  PSEXT  ,BS1    49
      2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE   ,BS1    50
      3        VJET    ,  VEXT    ,  XJET    ,  XEXT                          BS1    51
                                                                            BS1    52
C                                                                           BS1    53
       COMMON  ENDCM                                                        BS1    54
C                                                                           BS1    55
C      END OF COMMON TO BE COPIED TO RESTART FILE                           BS1    56
C                                                                           BS1    57
       COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                              BS1    58
C                                                                           BS1    59
C                                                                           BS1    60
       DIMENSION CPTB(1), HTP(1), GTB(1)                                    BS1    61
       DIMENSION IX(30)                                                     BS1    62
       EQUIVALENCE (ALOC(1,1),CPTB(1)), (ALOC(1,2),HTB(1))                  BS1    63
       EQUIVALENCE (ALOC(1,3),GTB(1))                                       BS1    64
       EQUIVALENCE (ITJOB,RTJOB)                                            BS1    65
       DIMENSION RIN(50), HOLD(50), HOLD2(50), HOLD3(50)                    BS1    66
       DATA LRSI/.FALSE./                                                   BS1    67
       CALL JPARAMS (IX)                                                    BS1    68
       ITJOB=IX(11)                                                         BS1    69
       RTJOB=RTJOB/60.0                                                     BS1    70
       RTJOB=AMAX1(RTJOB-0.5,0.1)                                           BS1    71
       READ (5,400) ITYPE,IFNAM,NAMAS,RTMAX,RTJOB,LSWON                     BS1    72
       IF (ITYPE.NE.0) GO TO 10                                             BS1    73
C                                                                           BS1    74
C      SAVE TIME PARAMETERS FOR AFTER RESTART                               BS1    75
C                                                                           BS1    76
C      RESTART - COPY COMMON                                                BS1    77
C                                                                           BS1    78
       CALL BOATRS (RTMAX,RTJOB)                                            BS1    79
       GO TO 330                                                            BS1    80
C                                                                           BS1    81
C      INITIALIZE TIME KEEPING VARIABLES                                    BS1    82
C                                                                           BS1    83
10     CONTINUE                                                             BS1    84
       IF (RTMAX.EQ.0.0) RTMAX=10.0                                         BS1    85
       IF (RTJOB.EQ.0.0) RTJOB=RTMAX                                        BS1    86
       RTACU=0.0                                                            BS1    87
       RTJAC=0.0                                                            BS1    88
C                                                                           BS1    89
       IFINIS=0                                                             BS1    90
       LHALF=.FALSE.
```

```
      READ (5,370) (TITLE(I),I=1,18)                                          BS1   91
      READ (5,340) MPSI,NMPSI,NS,NR,NT,IDELP,IPRESS,IVIS,IMAXJ,KMAXJ,IMABS1   92
     1XE,KMAXE,IOUT1,IOUT2,NRAD                                               BS1   93
      DELPSI=IDELP                                                            BS1   94
      MXNPT=MPSI                                                              BS1   95
      CALL SFVFL (0.0,ALPHA,25*MXNPT)                                         BS1   96
      MXNPI=MXNPT-1                                                           BS1   97
      NPSI=MPSI-1                                                             BS1   98
      READ (5,390) X,RJ,XMAX,PRNT,XCHANG,PRNTXC,FDL,DFDL                      BS1   99
      XINIT=X                                                                 BS1  100
      READ (5,390) XLE(1),SIGMA(1),TCONT,TKINET,CARBON,CNZINT,CVISC           BS1  101
      READ (5,390) P,U(1),U(MPSI),T(1),T(MPSI)                                BS1  102
      DXMIN=1.E-10                                                            BS1  103
      DX=.1*RJ                                                                BS1  104
      READ (5,390) FFF,GGG,PSID,DELJ,DELE,USTJ,USTE,RBUOY                     BS1  105
C                                                                             BS1  106
C     LOOK UP FILES                                                           BS1  107
C                                                                             BS1  108
      CALL BOATLU (0)                                                         BS1  109
      CARB=CARBON/(.78973-CNZINT)                                             BS1  110
      IF (TKINET.EQ.0.0) TKINET=400.0                                         BS1  111
C                                                                             BS1  112
C     THE VALUE OF 30 SECONDS IS TO ALLOW FOR COMPILE TIME                    BS1  113
C                                                                             BS1  114
      UNIT=U(1)                                                               BS1  115
      IF (DELPSI) 20,20,30                                                    BS1  116
20    READ (5,390) (ALPHA(J,1),J=1,NS)                                        BS1  117
      READ (5,390) (ALPHA(J,MPSI),J=1,NS)                                     BS1  118
      MMOD=MPSI-2                                                             BS1  119
      LRSI=.TRUE.                                                             BS1  120
      GO TO 60                                                                BS1  121
30    CONTINUE                                                                BS1  122
      LRSI=.TRUE.                                                             BS1  123
      READ (5,390) (RIN(I),I=1,MPSI)                                          BS1  124
      DO 40 I=1,MPSI                                                          BS1  125
40    RIN(I)=RIN(I)*RJ                                                        BS1  126
      READ (5,390) (T(I),I=1,MPSI)                                            BS1  127
      READ (5,390) (U(I),I=1,MPSI)                                            BS1  128
C                                                                             BS1  129
C     READ IN INITIAL XK PROFILE                                              BS1  130
C                                                                             BS1  131
      IF (IVIS.EQ.-2) READ (5,390) (XK(I),I=1,MPSI)                           BS1  132
C                                                                             BS1  133
      DO 50 I=1,MPSI                                                          BS1  134
50    READ (5,390) (ALPHA(J,I),J=1,NS)                                        BS1  135
```

```
C                                                                       BS1   136
C     NEW THERMO DATA DATA INPUT IN JANNAF TABLE FORM                   BS1   137
C                                                                       BS1   138
C                                                                       BS1   139
60    DO 90 I=1,NS                                                      BS1   140
      READ (5,360) AID(I),WTMOLE(I),HF(I)                               BS1   141
      DO 70 IT=1,NT,2                                                   BS1   142
      READ (5,350) TTB(IT),CPTB(IT),GTB(IT),HTB(IT),TTB(IT+1),CPTB(IT+1)BS1   143
     1,GTB(IT+1),HTB(IT+1)                                              BS1   144
      GTB(IT)=-GTB(IT)*TTB(IT)+HF(I)*1000.                              BS1   145
      GTB(IT+1)=-GTB(IT+1)*TTB(IT+1)+HF(I)*1000.                        BS1   146
      HTB(IT)=(HTB(IT)+HF(I))*1000.                                     BS1   147
      HTB(IT+1)=(HTB(IT+1)+HF(I))*1000.                                 BS1   148
70    CONTINUE                                                          BS1   149
      NRECS=(I-1)*30+1                                                  BS1   150
      CALL SFVMV (CPTB,CPTBV(NRECS),NT)                                 BS1   151
      CALL SFVMV (GTB,GTBV(NRECS),NT)                                   BS1   152
      CALL SFVMV (HTB,HTBV(NRECS),NT)                                   BS1   153
      IF (WTMOLE(I)-1.0) 80,90,90                                       BS1   154
80    IECC=I                                                            BS1   155
90    CONTINUE                                                          BS1   156
      IF (NR.LE.0) GO TO 130                                            BS1   157
      DO 120 I=1,NR                                                     BS1   158
      READ (5,380) (ZID(J),J=1,5),IRR(I),IRT(I),(RC(I,K),K=1,3)         BS1   159
      DO 110 J=1,5                                                      BS1   160
      IRRR(I,J)=0                                                       BS1   161
      DO 110 L=1,NS                                                     BS1   162
      IF (ZID(J)-AID(L)) 110,100,110                                    BS1   163
100   IRRR(I,J)=L                                                       BS1   164
110   CONTINUE                                                          BS1   165
120   CONTINUE                                                          BS1   166
130   CONTINUE                                                          BS1   167
C                                                                       BS1   168
C     READ IN INVISCID DATA MAP                                         BS1   169
C                                                                       BS1   170
      IF (IPRESS.NE.0) CALL BOATIF                                      BS1   171
C                                                                       BS1   172
      IF (DELPSI.LE.0.) CALL BOATIP (RIN)                               BS1   173
      IF (IPRESS.NE.0) P=P/2117.                                        BS1   174
C     R TO PSI MOD. - MAIN SECTION - 7/2/76 ARAP BY RAB                 BS1   175
C                                                                       BS1   176
      IF (.NOT.LRSI) GO TO 280                                          BS1   177
C                                                                       BS1   178
C     CONVERT R TO PSI                                                  BS1   179
      HOLD2(1)=P*SMPR2(NS,ALPHA(1,1),WTMOLE)/42.285/T(1)                BS1   180
      TEMZ=HOLD2(1)*U(1)
```

```
      HOLD(1)=TEMZ*RIN(1)**2                                                BS1  181
      IF (IPRESS.EQ.0) GO TO 170                                            BS1  182
      IDUM=KMAXJ                                                            BS1  183
140   PSA=FLOAT(IDUM-1)/FLOAT(KMAXJ-1)*PSJET                                BS1  184
      CALL BOATII (1,X,PSA,IMAXJ,KMAXJ,IJET,VJET,XJET,PSJET,YA,DUM,DUM,DBS1  185
     1UM,PSJET,FID,NRJET)                                                   BS1  186
      IF (IDUM.EQ.KMAXJ) GO TO 150                                          BS1  187
      IF (RIN(1).GE.YA) GO TO 160                                           BS1  188
150   IDUM=IDUM-1                                                           BS1  189
      PSB=PSA                                                               BS1  190
      YB=YA                                                                 BS1  191
      GO TO 140                                                             BS1  192
160   HOLD(1)=PSA+(RIN(1)-YA)/(YB-YA)*(PSB-PSA)                             BS1  193
      HOLD(1)=HOLD(1)**2                                                    BS1  194
      TEMZ=HOLD(1)/(RIN(1)**2)                                              BS1  195
170   CONTINUE                                                              BS1  196
      IPITER=0                                                              BS1  197
180   CONTINUE                                                              BS1  198
      IF (IPITER.EQ.0) GO TO 190                                            BS1  199
      DUMPSI=HOLD(1)                                                        BS1  200
      TEMZ=(HOLD(1)/RIN(1))**2                                              BS1  201
190   CONTINUE                                                              BS1  202
      DO 200 I=2,MPSI                                                       BS1  203
      TEMM=TEMZ                                                             BS1  204
C     HOLD2 CONTAINS THE DENSITY IN APPROPRIATE UNITS FOR PSI               BS1  205
C     ALPHA USED HERE AS MOLE FRACTIONS                                     BS1  206
      IF (IPITER.GT.0) P=P1+(HOLD(I)-DUMPSI)/(HOLD(MPSI)-DUMPSI)*(P2-P1)BS1  207
      HOLD2(I)=P*SMPR2(NS,ALPHA(1,I),WTMOLE)/42.285/T(I)                    BS1  208
      TEMZ=HOLD2(I)*U(I)                                                    BS1  209
      DUM=.5*(TEMM+TEMZ)                                                    BS1  210
      IF ((I.EQ.2).AND.(IPITER.GT.0)) HOLD(1)=HOLD(1)**2                    BS1  211
      HOLD(I)=HOLD(I-1)+DUM*(RIN(I)**2-RIN(I-1)**2)                         BS1  212
200   CONTINUE                                                              BS1  213
      DO 210 I=1,MPSI                                                       BS1  214
210   HOLD(I)=SQRT(HOLD(I))                                                 BS1  215
      IF (IPRESS.EQ.0) GO TO 220                                            BS1  216
      IF (IPITER.GT.0) GO TO 220                                            BS1  217
      CALL BOATII (1,X,HOLD(1),IMAXJ,KMAXJ,IJET,VJET,XJET,PSJET,DUM,P1,DBS1  218
     1UM,DUM,PSJET,FID,NRJET)                                               BS1  219
      CALL BOATII (2,X,HOLD(MPSI),IMAXE,KMAXE,IEXT,VEXT,XEXT,PSEXT,DUM,PBS1  220
     12,DUM,DUM,PSJET,FID,NREXT)                                            BS1  221
      P1=P1/2117.                                                           BS1  222
      P2=P2/2117.                                                           BS1  223
      IPITER=1                                                              BS1  224
      GO TO 180                                                             BS1  225
```

```
220   CONTINUE                                                          BS1  276
      IF (IPRESS.EQ.0) PSJET=RJ*SQRT(HOLD2(1)*U(1))                     BS1  277
      PSID=PSJET                                                        BS1  278
      YINTR=RJ                                                          BS1  279
      IF (IPRESS.NE.0) CALL BOATII (1,X,PSJET,IMAXJ,KMAXJ,IJET,VJET,XJETBS1  280
     1,PSJET,YINTR,DUM,DUM,DUM,PSJET,FID,NREXT)                         BS1  281
      IF (IPRESS.NE.0) CALL BOATLI (YINTR,PSID,RIN,HOLD,MPSI)           BS1  282
C                                                                       BS1  283
C     NOTE REDEFINITION OF DELPSI                                       BS1  284
      DELPSI=(HOLD(MPSI)-HOLD(1))/FLOAT(NPSI)                           BS1  285
C                                                                       BS1  286
C     INTERPOLATE INPUT VARIABLES FOR = PSI SPACING                     BS1  287
C                                                                       BS1  288
      CALL SFVMV (U,HOLD2,MPSI)                                         BS1  289
      CALL SFVMV (T,HOLD3,MPSI)                                         BS1  290
C                                                                       BS1  291
      IF (IVIS.EQ.-2) CALL SFVMV (XK,HOLD1,MPSI)                        BS1  292
C                                                                       BS1  293
      MSAV=MPSI                                                         BS1  294
      IF (IDELP.NE.1) GO TO 230                                         BS1  295
      IF (NMPSI.EQ.MPSI) GO TO 230                                      BS1  296
      MPSI=NMPSI                                                        BS1  297
      NPSI=MPSI-1                                                       BS1  298
      DELPSI=DELPSI*FLOAT(MSAV-1)/FLOAT(MPSI-1)                         BS1  299
230   CONTINUE                                                          BS1  300
C                                                                       BS1  301
      DO 240 I=1,MPSI                                                   BS1  302
      PSI(I)=HOLD(1)+DELPSI*FLOAT(I-1)                                  BS1  303
      CALL BOATLI (PSI(I),U(I),HOLD,HOLD2,MSAV)                         BS1  304
      CALL BOATLI (PSI(I),T(I),HOLD,HOLD3,MSAV)                         BS1  305
C                                                                       BS1  306
      IF (IVIS.EQ.-2) CALL BOATLI (PSI(I),XK(I),HOLD,HOLD1,MSAV)        BS1  307
C                                                                       BS1  308
240   CONTINUE                                                          BS1  309
C                                                                       BS1  310
      DO 270 J=1,NS                                                     BS1  311
      DO 250 I=1,MSAV                                                   BS1  312
      HOLD2(I)=ALPHA(J,I)                                               BS1  313
250   CONTINUE                                                          BS1  314
C                                                                       BS1  315
      DO 260 I=1,MPSI                                                   BS1  316
      CALL BOATLI (PSI(I),ALPHA(J,I),HOLD,HOLD2,MSAV)                   BS1  317
260   CONTINUE                                                          BS1  318
C                                                                       BS1  319
270   CONTINUE                                                          BS1  320
```

```
C
C       END OF MAIN SECTION R TO PSI MOD.                                  BS1  271
280     CONTINUE                                                           BS1  272
C       INITIALIZE DELTA STAR CALCULATION                                  BS1  273
        DELJ=DELE/RJ                                                       BS1  274
C                                                                          BS1  275
        DO 310 I=1,MPSI                                                    BS1  276
        WTVR=0.0                                                           BS1  277
        DO 290 J=1,NS                                                      BS1  278
290     WTVR=WTVR+ALPHA(J,I)*WTMOLE(J)                                     BS1  279
        DO 300 J=1,NS                                                      BS1  280
        ALPHA(J,I)=ALPHA(J,I)/WTVR                                         BS1  281
        RALPHA(J,I)=ALPHA(J,I)                                             BS1  282
300     CONTINUE                                                           BS1  283
310     CONTINUE                                                           BS1  284
        DO 320 I=1,MPSI                                                    BS1  285
        RU(I)=U(I)                                                         BS1  286
        RT(I)=T(I)                                                         BS1  287
        XLE(I)=XLE(1)                                                      BS1  288
320     SIGMA(I)=SIGMA(1)                                                  BS1  289
        CALL BOATIN                                                        BS1  290
        P=2117.0*P                                                         BS1  291
        DPDX=0.0                                                           BS1  292
330     RETURN                                                             BS1  293
C                                                                          BS1  294
340     FORMAT (15I5)                                                      BS1  295
350     FORMAT (8F10.4)                                                    BS1  296
360     FORMAT (A4,2X,7E10.3)                                              BS1  297
370     FORMAT (18A4)                                                      BS1  298
380     FORMAT (A4,3X,A4,10X,A4,3X,A4,3X,A4,9X,I2,I1,E8.2,F4.1,F9.1)       BS1  299
390     FORMAT (8E10.3)                                                    BS1  300
400     FORMAT (I1,1X,3A2,1X,3A2,1X,2F10.0,16(1X,L1))                      BS1  301
        END                                                                BS1  302
                                                                           BS1  303
```

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      SUBROUTINE BOATS2                                                  BS2     1
C                                                                        BS2     2
C       BOATS2 - REACTION CALCULATION                                    BS2     3
C                                                                        BS2     4
C       BOATCM - BOAT COMMON                                             BS2     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),   BS2     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),      BS2     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),    BS2     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),   BS2     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),  BS2    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),       BS2    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BS2    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),      BS2    13
     8 YOUT(50), ZID(5)                                                  BS2    14
C                                                                        BS2    15
      LOGICAL LHALF,LSWON                                                BS2    16
C                                                                        BS2    17
      EQUIVALENCE (J1, J12345(1))                                        BS2    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                   BS2    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                      BS2    20
      EQUIVALENCE (CPTBV, CGHV)                                          BS2    21
      EQUIVALENCE (HCP(1,1), WM(1))                                      BS2    22
      EQUIVALENCE (START, TTB(1))                                        BS2    23
C                                                                        BS2    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV              BS2    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BS2    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BS2    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BS2    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BS2    29
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BS2    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BS2    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BS2    32
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BS2    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BS2    34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BS2    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BS2    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BS2    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BS2    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BS2    39
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BS2    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BS2    41
     7        Y       ,  ZID                                            BS2    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)          BS2    43
C                                                                        BS2    44
C       JET/EXT FLOW FIELD COMMON SECTION                                BS2    45
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C                                                                       BS2   46
      COMMON  DELJ   , DELE   , IJET   , IEXT   , IMAXJ  , IMAXE  ,BS2   47
     1        KMAXJ  , KMAXE  , NRJET  , NREXT  , PSJET  , PSEXT  ,BS2   48
     2        P1     , P2     , P3     , P4     , USTJ   , USTE   ,BS2   49
     3        VJET   , VEXT   , XJET   , XEXT                       BS2   50
C                                                                       BS2   51
      COMMON  ENDCM                                                   BS2   52
C                                                                       BS2   53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BS2   54
C                                                                       BS2   55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                         BS2   56
C                                                                       BS2   57
C                                                                       BS2   58
      R=82.06                                                         BS2   59
      AV=6.025E23                                                     BS2   60
      DO 330 L=1,NPSI                                                 BS2   61
      RRT=1.986*T(L)                                                  BS2   62
      ROOTT=SQRT(T(L))                                                BS2   63
      TX=T(L)                                                         BS2   64
      CALL BOATTK (TX,TTR,ITKEY,SDT,HDT,NT)                           BS2   65
      IF (ITKEY.EQ.0) CALL EXIT                                       BS2   66
      CALL SFVFL (0.0,WP,25)                                          BS2   67
      CALL SFVFL (0.0,WM,25)                                          BS2   68
      CALL SFVFL (0.0,CM,625)                                         BS2   69
      CALL SFVFL (0.0,QX,25)                                          BS2   70
      DO 10 I=1,NS                                                    BS2   71
      CALL BOATLP (ITKEY,I,3,SDT,HDT,AX)                              BS2   72
      G(I)=AX                                                         BS2   73
10    CONTINUE                                                        BS2   74
C                                                                       BS2   75
C     REACTION CALCULATION                                            BS2   76
C     REACTION KINETICS CONTINUE DOWN TO 400 DEGREES K                BS2   77
C        UNLESS TKINET IS SET TO A VALUE OTHER THAN 400 K             BS2   78
C     REACTION KINETICS FOR ALL REACTIONS CONTINUE DOWN TO TKINET      BS2   79
C                                                                       BS2   80
      IF (NR.LE.0) GO TO 280                                          BS2   81
      IF (T(L)-TKINET) 280,280,20                                     BS2   82
20    CONTINUE                                                        BS2   83
      DO 270 I=1,NR                                                   BS2   84
      TEMRP=0.0                                                       BS2   85
      TEMRM=0.0                                                       BS2   86
      KK=IRT(I)                                                       BS2   87
C                                                                       BS2   88
C     REACTION CONSTANT TYPE                                          BS2   89
C                                                                       BS2   90
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      GO TO (30,40,50,60,70,80,90,100), KK                                BS2   91
30    RATE=RC(I,1)*AV                                                     BS2   92
      GO TO 110                                                           BS2   93
40    RATE=RC(I,1)/T(L)*AV                                                BS2   94
      GO TO 110                                                           BS2   95
50    RATE=RC(I,1)/T(L)/T(L)*AV                                           BS2   96
      GO TO 110                                                           BS2   97
60    RATE=RC(I,1)/ROOTT*AV                                               BS2   98
      GO TO 110                                                           BS2   99
70    RATE=RC(I,1)*EXP(RC(I,3)/RRT)*AV                                    BS2  100
      GO TO 110                                                           BS2  101
80    RATE=RC(I,1)*EXP(RC(I,3)/RRT)/T(L)*AV                               BS2  102
      GO TO 110                                                           BS2  103
90    RATE=RC(I,1)/T(L)/ROOTT*AV                                          BS2  104
      GO TO 110                                                           BS2  105
100   RATE=RC(I,1)*EXP(RC(I,3)/RRT)/(T(L)**RC(I,2))*AV                    BS2  106
110   CONTINUE                                                            BS2  107
      X=IRR(I)                                                            BS2  108
C                                                                         BS2  109
C     TYPE OF REACTION                                                    BS2  110
C                                                                         BS2  111
      DO 120 N=1,5                                                        BS2  112
120   J12345(N)=IRRR(I,N)                                                 BS2  113
      GO TO (150,160,170,130,140,200,210,220,180,190), K                  BS2  114
130   CONTINUE                                                            BS2  115
      E=BOATEF(K,3,RRT)                                                   BS2  116
      CRR=RATE*RHOOUT(L)                                                  BS2  117
      TEMRP=CRR*RHOOUT(L)*ALPHA(J1,L)*ALPHA(J2,L)                         BS2  118
      TEMRM=CRR*ALPHA(J3,L)/E/R/T(L)                                      BS2  119
      CALL BOATCC (K,I,L,3,3,1.0,0.0)                                     BS2  120
140   CONTINUE                                                            BS2  121
      J2=25                                                               BS2  122
      E=BOATEF(K,4,RRT)                                                   BS2  123
      CRR=RATE*RHOOUT(L)*RHOOUT(L)*WTMIX(L)                               BS2  124
      TEMRP=CRR*ALPHA(J1,L)                                               BS2  125
      TEMRM=CRR*R*T(L)*RHOOUT(L)*ALPHA(J3,L)*ALPHA(J4,L)/E                BS2  126
      CALL BOATCC (K,I,L,4,4,-1.0,0.0)                                    BS2  127
      GO TO 240                                                           BS2  128
150   CONTINUE                                                            BS2  129
      E=BOATEF(K,4,RRT)                                                   BS2  130
      CRR=RATE*RHOOUT(L)*RHOOUT(L)                                        BS2  131
      TEMRP=CRR*ALPHA(J1,L)*ALPHA(J2,L)                                   BS2  132
      TEMRM=CRR*ALPHA(J3,L)*ALPHA(J4,L)/E                                 BS2  133
      CALL BOATCC (K,I,L,4,4,1.0,-1.0)                                    BS2  134
      GO TO 240                                                           BS2  135
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C                                                                       BS2  136
160   CONTINUE                                                          BS2  137
      E=BOATEF(K,3,RRT)                                                 BS2  138
      CRR=RATE*RHOOUT(L)*PHOOUT(L)*WTMIX(L)*AV                          BS2  139
      TEMRP=CRR*RHOOUT(L)*ALPHA(J1,L)*ALPHA(J2,L)                       BS2  140
      TEMRM=CRR*ALPHA(J3,L)/E/R/T(L)                                    BS2  141
      CALL BOATCC (K,I,L,3,3,1.0,0.0)                                   BS2  142
      GO TO 250                                                         BS2  143
C                                                                       BS2  144
170   CONTINUE                                                          BS2  145
      E=BOATEF(K,5,RRT)                                                 BS2  146
      CRR=RATE*RHOOUT(L)*RHOOUT(L)                                      BS2  147
      TEMRP=CRR*ALPHA(J1,L)*ALPHA(J2,L)                                 BS2  148
      TEMRM=CRR*ALPHA(J3,L)*ALPHA(J4,L)*ALPHA(J5,L)*RHOOUT(L)*R*T(L)/E  BS2  149
      CALL BOATCC (K,I,L,5,5,1.0,-2.0)                                  BS2  150
      GO TO 230                                                         BS2  151
C                                                                       BS2  152
180   CONTINUE                                                          BS2  153
      CRR=RATE*RHOOUT(L)                                                BS2  154
      TEMRP=CRR*RHOOUT(L)*ALPHA(J1,L)*ALPHA(J2,L)                       BS2  155
      TEMRM=0.0                                                         BS2  156
      CALL BOATCC (K,I,L,3,2,1.0,0.0)                                   BS2  157
      GO TO 250                                                         BS2  158
C                                                                       BS2  159
190   CONTINUE                                                          BS2  160
      J2=25                                                             BS2  161
      CRR=RATE*RHOOUT(L)*RHOOUT(L)*WTMIX(L)                             BS2  162
      TEMRP=CRR*ALPHA(J1,L)                                             BS2  163
      TEMRM=0.0                                                         BS2  164
      CALL BOATCC (K,I,L,4,1,1.0,0.0)                                   BS2  165
      GO TO 240                                                         BS2  166
C                                                                       BS2  167
200   CONTINUE                                                          BS2  168
      CRR=RATE*RHOOUT(L)*RHOOUT(L)                                      BS2  169
      TEMRP=CRR*ALPHA(J1,L)*ALPHA(J2,L)                                 BS2  170
      TEMRM=0.0                                                         BS2  171
      CALL BOATCC (K,I,L,4,2,1.0,0.0)                                   BS2  172
      GO TO 240                                                         BS2  173
C                                                                       BS2  174
210   CONTINUE                                                          BS2  175
      CRR=RATE*RHOOUT(L)*RHOOUT(L)*WTMIX(L)*AV                          BS2  176
      TEMRP=CRR*RHOOUT(L)*ALPHA(J1,L)*ALPHA(J2,L)                       BS2  177
      TEMRM=0.0                                                         BS2  178
      CALL BOATCC (K,I,L,3,2,1.0,0.0)                                   BS2  179
      GO TO 250                                                         BS2  180
```

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C                                                                       BS2  181
220   CONTINUE                                                          BS2  182
      CRR=RATE*RHOOUT(L)*PHOOUT(L)                                      BS2  183
      TEMRP=CRR*ALPHA(J1,L)*ALPHA(J2,L)                                 BS2  184
      TEMRM=0.0                                                         BS2  185
      CALL BOATCC (K,I,L,5,2,1.0,0.0)                                   BS2  186
C                                                                       BS2  187
C     CALCULATE WDOT                                                    BS2  188
C                                                                       BS2  189
230   WP(J5)=WP(J5)+TEMRP                                               BS2  190
      WM(J5)=WM(J5)+TEMRM                                               BS2  191
240   WP(J4)=WP(J4)+TEMRP                                               BS2  192
      WM(J4)=WM(J4)+TEMRM                                               BS2  193
250   WP(J3)=WP(J3)+TEMRP                                               BS2  194
      WM(J3)=WM(J3)+TEMRM                                               BS2  195
      WP(J2)=WP(J2)+TEMRM                                               BS2  196
      WM(J2)=WM(J2)+TEMRP                                               BS2  197
      WP(J1)=WP(J1)+TEMRM                                               BS2  198
      WM(J1)=WM(J1)+TEMRP                                               BS2  199
      IF (LSWON(3)) GO TO 260                                           BS2  200
      IF (IOUT2.LE.0) GO TO 270                                         BS2  201
      IF (IFINIS.EQ.0) GO TO 260                                        BS2  202
      IF (X.GE.XMAX) GO TO 260                                          BS2  203
      IF (PRNT.GT.PCNT) GO TO 270                                       BS2  204
260   NREC=(L-1)*25+I                                                   BS2  205
      CALL SFVMV (TEMRP,PPRM(NREC),2)                                   BS2  206
270   CONTINUE                                                          BS2  207
280   CONTINUE                                                          BS2  208
      IF (.NOT.LSWON(3)) GO TO 300                                      BS2  209
      WRITE (6,340) T(L),RHOOUT(L)                                      BS2  210
      DO 290 I=1,NS                                                     BS2  211
      NREC=(L-1)*25+I                                                   BS2  212
      CALL SFVMV (RPRM(NREC),TEMRP,2)                                   BS2  213
      WRITE (6,340) ALPHA(I,L),TEMRP,TEMRM                              BS2  214
290   CONTINUE                                                          BS2  215
300   CONTINUE                                                          BS2  216
      DO 310 J=1,NS                                                     BS2  217
310   WDOT(J,L)=(WP(J)-WM(J))/PHOOUT(L)/U(L)                            BS2  218
      DO 320 J=1,NS                                                     BS2  219
      CALL BOATLP (ITKEY,J,2,SOT,HOT,AX)                                BS2  220
      HCP(2,J)=AX*45055.31                                              BS2  221
      CALL BOATLP (ITKEY,J,4,SOT,HOT,AX)                                BS2  222
      HCP(1,J)=AX*45055.31                                              BS2  223
320   CONTINUE                                                          BS2  224
C                                                                       BS2  225
```

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      CALL BOATS3 (L)                                                   BS2  226
C                                                                       BS2  227
330   CONTINUE                                                          BS2  228
C                                                                       BS2  229
      RETURN                                                            BS2  230
C                                                                       BS2  231
340   FORMAT (1H ,10E13.5)                                              BS2  232
      END                                                               BS2  233
```

```
      SUBROUTINE BOATS3 (L)                                                  BS3     1
C                                                                            BS3     2
C       BOATS3 - INTEGRATION AND SLOP                                        BS3     3
C                                                                            BS3     4
C       BOATCM - BOAT COMMON                                                 BS3     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),       BS3     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),          BS3     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),        BS3     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),       BS3     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), PXE(50), RXK(50),      BS3    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),           BS3    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTM1X(50), WTMOLE(25),     BS3    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),          BS3    13
     8 YOUT(50), ZID(5)                                                      BS3    14
C                                                                            BS3    15
      LOGICAL LHALF,LSWON                                                    BS3    16
C                                                                            BS3    17
      EQUIVALENCE (J1, J12345(1))                                            BS3    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                       BS3    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                          BS3    20
      EQUIVALENCE (CPTBV, CGHV)                                              BS3    21
      EQUIVALENCE (HCP(1,1), WM(1))                                          BS3    22
      EQUIVALENCE (START, TTB(1))                                            BS3    23
C                                                                            BS3    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                   BS3    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BS3    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BS3    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BS3    28
     3        IDELP   ,  IFCC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BS3    29
     4        IPAGE   ,  IPRESS ,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BS3    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BS3    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BS3    32
     7        NPSI    ,  NP    ,  NPAD   ,  NRAS   ,  NS     ,  NT     ,BS3    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BS3    34
     9        QX      ,  RALPHA ,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BS3    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BS3    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BS3    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BS3    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BS3    39
     5        WTMIX   ,  WTMOLE ,  X      ,  XCHANG ,  XD     ,  XE     ,BS3    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BS3    41
     7        Y       ,  ZID                                              BS3    42
      COMMON  FLOWX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)             BS3    43
C                                                                            BS3    44
C     JET/EXT FLOW FIELD COMMON SECTION                                      BS3    45
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C                                                                       BS3    46
      COMMON  DELJ   ,  DELE   ,  IJET   ,  IEXT   ,  IMAXJ  ,  IMAXE  ,BS3    47
     1        KMAXJ  ,  KMAXE  ,  NRJET  ,  NREXT  ,  PSJET  ,  PSEXT  ,BS3    48
     2        P1     ,  P2     ,  P3     ,  P4     ,  USTJ   ,  USTE   ,BS3    49
     3        VJET   ,  VEXT   ,  XJET   ,  XEXT                        BS3    50
C                                                                       BS3    51
      COMMON  ENDCM                                                     BS3    52
C                                                                       BS3    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BS3    54
C                                                                       BS3    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BS3    56
C                                                                       BS3    57
C                                                                       BS3    58
C     DEBUG EX1, EX6, EX7, EX5                                          BS3    59
C                                                                       BS3    60
      C1=SPACR(6)                                                       BS3    61
      C2=SPACR(7)                                                       BS3    62
C                                                                       BS3    63
      I=L                                                               BS3    64
      DPDX=0.                                                           BS3    65
      IF (IPRESS.EQ.0) GO TO 10                                         BS3    66
      IF (PSI(I).LT.PSJET) CALL BOATII (3,X,PSI(I),IMAXJ,KMAXJ,IJET,VJETBS3    67
     1,XJET,PSJET,YAX,DPDX,TAX,UAX,PSJET,FID,NRJET)                     BS3    68
      IF (PSI(I).GE.PSJET) CALL BOATII (4,X,PSI(I),IMAXE,KMAXE,IEXT,VEXTBS3    69
     1,XEXT,PSEXT,YBX,DPDX,TBX,UBX,PSJET,FID,NREXT)                     BS3    70
10    CONTINUE                                                          BS3    71
C                                                                       BS3    72
C     HCP IS WORKING VECTOR OF (H, CP) UP TO NS PAIRS                   BS3    73
C                                                                       BS3    74
      IF (I.EQ.1) GO TO 80                                              BS3    75
      IF (.NOT.LSWON(2)) GO TO 20                                       BS3    76
      WRITE (6,160) PSI(I),A(I),U(I),RHO(I),XLE(I),SIGMA(I),CPBAR(I),RHOBS3    77
     1OUT(I)                                                            BS3    78
      WRITE (6,160) (WDOT(J,I),J=1,NS)                                  BS3    79
      WRITE (6,160) (HCP(2,J),J=1,NS)                                   BS3    80
      WRITE (6,160) (ALPHA(J,I),J=1,NS)                                 BS3    81
20    CONTINUE                                                          BS3    82
      EX1=PSI(I)*DELPSI**2/DX                                           BS3    83
      EX11=.5*(A(I)+A(I+1))                                             BS3    84
      EX12=.5*(A(I)+A(I-1))                                             BS3    85
C                                                                       BS3    86
C     INTEGRATE MOMENTUM EQUATION                                       BS3    87
C                                                                       BS3    88
      RU(I)=(EX11*(U(I+1)-U(I))+EX12*(U(I-1)-U(I)))/EX1+U(I)            BS3    89
      RU(I)=RU(I)-DX*DPDX/RHO(I)/U(I)+RBUOY*DX*(RHO(MPSI)-RHO(I))*32.174BS3    90
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     1/RHO(I)/U(I)                                                          BS3   91
      TERM1=(EX11*(U(I+1)-U(I))+EX12*(U(I-1)-U(I)))/EX1                     BS3   92
      TERM2=RBUOY*DX*(RHO(MPSI)-RHO(I))*32.174/RHO(I)/U(I)                  BS3   93
      IF (LSWON(13)) WRITE (6,170) X,I,TERM1,TERM2                          BS3   94
      EX3=0.0                                                               BS3   95
      EX4=0.0                                                               BS3   96
      DO 30 J=1,NS                                                          BS3   97
      EX3=EX3+HCP(1,J)*WDOT(J,I)                                            BS3   98
30    EX4=EX4+HCP(2,J)*(ALPHA(J,I+1)-ALPHA(J,I-1))                          BS3   99
      EX2=EX1*CPBAR(I)                                                      BS3  100
      EX5=XLE(I)*A(I)/SIGMA(I)                                              BS3  101
      EX6=.5*(EX5+XLE(I+1)*A(I+1)/SIGMA(I+1))                               BS3  102
      EX7=.5*(EX5+XLE(I-1)*A(I-1)/SIGMA(I-1))                               BS3  103
      EX8=CPBAR(I)*A(I)/SIGMA(I)                                            BS3  104
      EX9=.5*(EX8+CPBAR(I+1)*A(I+1)/SIGMA(I+1))                             BS3  105
      EX10=.5*(EX8+CPBAR(I-1)*A(I-1)/SIGMA(I-1))                            BS3  106
      EX14=EX4*EX5/4.0                                                      BS3  107
C                                                                           BS3  108
C     INTEGRATE ENERGY EQUATION                                             BS3  109
C                                                                           BS3  110
      RT(I)=(U(I+1)-U(I-1))**2*A(I)/EX2/4.0+DX*DPDX/RHO(I)/CPBAR(I)+T(I)    BS3  111
     1+((EX9+EX14)*T(I+1)+(EX10-EX14)*T(I-1)-(EX9+EX10)*T(I))/EX2-EX3*DX    BS3  112
     2/CPBAR(I)                                                             BS3  113
      RHOUIX=DX/(RHOOUT(I)*U(I))                                            BS3  114
C                                                                           BS3  115
C     INTEGRATE SPECIES EQUATIONS                                           BS3  116
C                                                                           BS3  117
      IF (LSWON(2)) WRITE (6,160) (QX(J),J=1,NS)                            BS3  118
      DO 40 J=1,NS                                                          BS3  119
40    QX(J)=(EX6*(ALPHA(J,I+1)-ALPHA(J,I))+EX7*(ALPHA(J,I-1)-ALPHA(J,I))    BS3  120
     1)/EX1+ALPHA(J,I)+QX(J)*RHOUIX                                         BS3  121
      DO 50 M=1,NS                                                          BS3  122
      DO 50 N=1,NS                                                          BS3  123
      CM(M,N)=CM(M,N)*RHOUIX                                                BS3  124
      IF (M.EQ.N) CM(M,N)=CM(M,N)+1.0                                       BS3  125
50    CONTINUE                                                              BS3  126
      CALL BOATSL (QX,CM,NS)                                                BS3  127
C                                                                           BS3  128
C                                                                           BS3  129
      DO 60 J=1,NS                                                          BS3  130
60    RALPHA(J,I)=QX(J)                                                     BS3  131
C                                                                           BS3  132
C     INTEGRATE TKE EQUATIONS                                               BS3  133
C                                                                           BS3  134
      IF (IVIS.GE.0) GO TO 70                                               BS3  135
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```
      RXK(I)=XK(I)+(EX11*(XK(I+1)-XK(I))+EX12*(XK(I-1)-XK(I)))/EX1/SIGK+BS3   136
     1(U(I+1)-U(I-1))**2*A(I)/EX1/4.-XE(I)/U(I)*DX                          BS3   137
      RXE(I)=XE(I)+(EX11*(XE(I+1)-XE(I))+EX12*(XE(I-1)-XE(I)))/EX1/SIGE+BS3   138
     1C1*(U(I+1)-U(I-1))**2*XE(I)*A(I)/EX1/XK(I)/4.-C2*XE(I)**2/U(I)/XK(BS3   139
     2I)*DX                                                                 BS3   140
70    CONTINUE                                                              BS3   141
C                                                                           BS3   142
      GO TO 150                                                             BS3   143
80    CONTINUE                                                              BS3   144
      IF (PSI(1).GT.0.) GO TO 130                                           BS3   145
      EX3=4.0*XMU(1)*DX/DELPSI/DELPSI                                       BS3   146
      RHOUIX=DX/(RHOOUT(1)*U(1))                                            BS3   147
C                                                                           BS3   148
C     COMPUTE U AT CENTER LINE                                              BS3   149
C                                                                           BS3   150
      RU(1)=EX3*(U(2)-U(1))+U(1)-DX*DPDX/RHO(1)/U(1)+RBUOY*DX*(RHO(MPSI)BS3   151
     1-RHO(1))*32.174/RHO(1)/U(1)                                           BS3   152
      TERM3=EX3*(U(2)-U(1))                                                 BS3   153
      TERM4=RBUOY*DX*(RHO(MPSI)-RHO(1))*32.174/RHO(1)/U(1)                  BS3   154
      IF (LSWON(13)) WRITE (6,170) X,I,TERM3,TERM4                          BS3   155
      EX4=0.0                                                               BS3   156
      DO 90 J=1,NS                                                          BS3   157
      EX4=EX4+HCP(1,J)*WDOT(J,1)                                            BS3   158
      RALPHA(J,MPSI)=ALPHA(J,MPSI)                                          BS3   159
90    QX(J)=EX3*XLE(1)*(ALPHA(J,2)-ALPHA(J,1))/SIGMA(1)+ALPHA(J,1)+QX(J)BS3   160
     1*RHOUIX                                                               BS3   161
      DO 100 M=1,NS                                                         BS3   162
      DO 100 N=1,NS                                                         BS3   163
      CM(M,N)=CM(M,N)*RHOUIX                                                BS3   164
      IF (M.EQ.N) CM(M,N)=CM(M,N)+1.0                                       BS3   165
100   CONTINUE                                                              BS3   166
      CALL BOATSL (QX,CM,NS)                                                BS3   167
C                                                                           BS3   168
C                                                                           BS3   169
      DO 110 J=1,NS                                                         BS3   170
C                                                                           BS3   171
C     COMPUTE SPECIES AT CENTER LINE                                        BS3   172
C                                                                           BS3   173
110   RALPHA(J,1)=QX(J)                                                     BS3   174
C                                                                           BS3   175
C     CALCULATE TEMP. AT CENTER LINE                                        BS3   176
C                                                                           BS3   177
      RT(1)=EX3*(T(2)-T(1))/SIGMA(1)+T(1)+DX*DPDX/RHO(1)/CPBAR(1)-EX4*DXBS3   178
     1/CPBAR(1)                                                             BS3   179
C                                                                           BS3   180
```

```
C       INTEGRATE TKE EQUATIONS AT CENTERLINE                                   BS3  181
C                                                                               BS3  182
        IF (IVIS.GE.0) GO TO 120                                                BS3  183
        RXK(1)=XK(1)+EX3*(XK(2)-XK(1))/SIGK-XE(1)/U(1)*DX                       BS3  184
        IF (XK(1).LT.1.E-20) XK(1)=1.E-20                                       BS3  185
        RXE(1)=XE(1)+EX3*(XE(2)-XE(1))/SIGE-C2*XE(1)**2/U(1)/XK(1)*DX           BS3  186
        DUMK=RXK(1)/RXK(2)                                                      BS3  187
        IF (DUMK.LT..1) RXK(1)=RXK(2)                                           BS3  188
        DUME=RXE(1)/RXE(2)                                                      BS3  189
        IF (DUME.LT..1) RXE(1)=RXE(2)                                           BS3  190
120     CONTINUE                                                                BS3  191
C                                                                               BS3  192
        GO TO 150                                                               BS3  193
130     CONTINUE                                                                BS3  194
        DO 140 J=1,NS                                                           BS3  195
        RALPHA(J,1)=ALPHA(J,1)                                                  BS3  196
        RALPHA(J,MPSI)=ALPHA(J,MPSI)                                            BS3  197
140     CONTINUE                                                                BS3  198
        IF (IVIS.GE.0) GO TO 150                                                BS3  199
        RXK(1)=0.                                                               BS3  200
        RXE(1)=0.                                                               BS3  201
        RXK(MPSI)=0.                                                            BS3  202
        RXE(MPSI)=0.                                                            BS3  203
150     CONTINUE                                                                BS3  204
        RETURN                                                                  BS3  205
C                                                                               BS3  206
160     FORMAT (1H ,10E13.5)                                                    BS3  207
170     FORMAT (1H ,E13.5,I6,2E13.5)                                            BS3  208
        END                                                                     BS3  209
```

```
      SUBROUTINE BOATTK (T,TTB,ITKEY,SDT,HDT,NT)                        BTK     1
      DIMENSION TTB(30)                                                 BTK     2
      NT1=NT-1                                                          BTK     3
      DO 10 IT=1,NT1                                                    BTK     4
      DT=TTB(IT+1)-TTB(IT)                                              BTK     5
      SDT=(T-TTB(IT))/DT                                                BTK     6
      HDT=(TTB(IT+1)-T)/DT                                              BTK     7
      IF ((SDT*HDT).GE.0.0) GO TO 20                                    BTK     8
10    CONTINUE                                                          BTK     9
      WRITE (6,30) T,IT                                                 BTK    10
      ITKEY=0                                                           BTK    11
      RETURN                                                            BTK    12
20    ITKEY=IT                                                          BTK    13
      RETURN                                                            BTK    14
C                                                                       BTK    15
30    FORMAT (1H ,28H   TEMPEPATURE OUT OF RANGE ,E14.5,I5)             BTK    16
      END                                                               BTK    17
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```
      SUBROUTINE BOATVI                                                 BVI     1
C                                                                       BVI     2
C     TURBULENT VISCOSITY ROUTINE                                       BVI     3
C                                                                       BVI     4
C       BOATCM - BOAT COMMON                                            BVI     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),  BVI     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),     BVI     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),   BVI     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),  BVI     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50), BVI    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),      BVI    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BVI    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),     BVI    13
     8 YOUT(50), ZID(5)                                                 BVI    14
C                                                                       BVI    15
      LOGICAL LHALF,LSWON                                               BVI    16
C                                                                       BVI    17
      EQUIVALENCE (J1, J12345(1))                                       BVI    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                  BVI    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                     BVI    20
      EQUIVALENCE (CPTBV, CGHV)                                         BVI    21
      EQUIVALENCE (HCP(1,1), WM(1))                                     BVI    22
      EQUIVALENCE (START, TTB(1))                                       BVI    23
C                                                                       BVI    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV            BVI    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BVI    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BVI    27
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BVI    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BVI    29
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BVI    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BVI    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BVI    32
     7        NPSI    ,  NP    ,  NPAD   ,  NRAS   ,  NS     ,  NT     ,BVI    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BVI    34
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BVI    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BVI    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BVI    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BVI    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BVI    39
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,BVI    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BVI    41
     7        Y       ,  ZID                                           BVI    42
      COMMON  FLOTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)         BVI    43
C                                                                       BVI    44
C     JET/EXT FLOW FIELD COMMON SECTION                                 BVI    45
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C                                                                       BVI    46
      COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE  ,BVI    47
     1        KMAXJ   ,  KMAXE   ,  NRJET   ,  NREXT   ,  PSJET   ,  PSEXT  ,BVI    48
     2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE   ,BVI    49
     3        VJET    ,  VEXT    ,  XJET    ,  XEXT                          BVI    50
C                                                                       BVI    51
      COMMON  ENDCM                                                     BVI    52
C                                                                       BVI    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                        BVI    54
C                                                                       BVI    55
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                           BVI    56
C                                                                       BVI    57
C                                                                       BVI    58
      IF (IVIS.LE.0) GO TO 50                                           BVI    59
C     LOCATE RBOT(WHERE U-U1/U2-U1 = CBOT)                              BVI    60
      CBOT=.95                                                          BVI    61
      UT=U(MPSI)+CBOT*(U(1)-U(MPSI))                                    BVI    62
      DO 10 I=2,MPSI                                                    BVI    63
      IF (U(I).LT.UT) GO TO 20                                          BVI    64
10    CONTINUE                                                          BVI    65
20    CONTINUE                                                          BVI    66
      RAT=(UT-U(I-1))/(U(I)-U(I-1))                                     BVI    67
      RBOT=Y(I-1)+RAT*(Y(I)-Y(I-1))                                     BVI    68
      UDUM=U(1)/UNIT                                                    BVI    69
      IF (PSI(1).EQ.0..AND.UDUM.LT.GGG) RBOT=0.                         BVI    70
      IF (IDELP.EQ.-1) RBOT=Y(1)                                        BVI    71
C     LOCATE RTOP(WHERE U-U1/U2-U1 = CTOP)                              BVI    72
      CTOP=.05                                                          BVI    73
      UT=U(MPSI)+CTOP*(U(1)-U(MPSI))                                    BVI    74
      DO 30 II=1,NPSI                                                   BVI    75
      I=NPSI-II+1                                                       BVI    76
      IF (U(I).GT.UT) GO TO 40                                          BVI    77
30    CONTINUE                                                          BVI    78
40    CONTINUE                                                          BVI    79
      RAT=(UT-U(I+1))/(U(I)-U(I+1))                                     BVI    80
      RTOP=Y(I+1)+RAT*(Y(I)-Y(I+1))                                     BVI    81
      IF (IDELP.EQ.-1) RTOP=Y(MPSI)                                     BVI    82
50    CONTINUE                                                          BVI    83
      XMU(1)=0.                                                         BVI    84
      XMU(MPSI)=0.                                                      BVI    85
      IF (IVIS) 200,60,140                                              BVI    86
60    CONTINUE                                                          BVI    87
C                                                                       BVI    88
C     PRANDTL MIXING LENGTH MODEL.                                      BVI    89
C                                                                       BVI    90
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      IF (PSI(1).EQ.0.) FFF=GGG                                          BVI   91
      DELTA=Y(MPSI)-Y(1)                                                 BVI   92
      XL=FFF*DELTA                                                       BVI   93
      IF (PSI(1).NE.0.) GO TO 70                                         BVI   94
      D2UDY2=2.*(U(2)-U(1))/(Y(2)-Y(1))**2                               BVI   95
      D2UDY2=ABS(D2UDY2)                                                 BVI   96
      XMU(1)=RHO(1)*XL**3*D2UDY2                                         BVI   97
70    CONTINUE                                                           BVI   98
      IL=0                                                               BVI   99
      IF (PSI(1).EQ.0.) GO TO 110                                        BVI  100
C     DUAL LENGTH SCALE TEST                                             BVI  101
      UMIN=AMIN1(U(1),U(MPSI))*.95                                       BVI  102
      DO 80 I=2,NPSI                                                     BVI  103
      IF (U(I).GT.UMIN) GO TO 80                                         BVI  104
      IL=I                                                               BVI  105
      UMIN=U(I)                                                          BVI  106
80    CONTINUE                                                           BVI  107
      IF (IL.GT.0) GO TO 100                                             BVI  108
      UMAX=AMAX1(U(1),U(MPSI))*1.05                                      BVI  109
      DO 90 I=2,NPSI                                                     BVI  110
      IF (U(I).LT.UMAX) GO TO 90                                         BVI  111
      IL=I                                                               BVI  112
      UMAX=U(I)                                                          BVI  113
90    CONTINUE                                                           BVI  114
100   CONTINUE                                                           BVI  115
      IF (IL.EQ.0) GO TO 110                                             BVI  116
      XL1=FFF*(Y(IL)-Y(1))                                               BVI  117
      XL2=FFF*(Y(MPSI)-Y(IL))                                            BVI  118
110   CONTINUE                                                           BVI  119
      DO 130 I=2,NPSI                                                    BVI  120
      DUDY=(U(I+1)-U(I-1))/2./DELPSI*RHO(I)*U(I)*Y(I)/PSI(I)             BVI  121
      DUDY=ABS(DUDY)                                                     BVI  122
      IF (IL.EQ.0) GO TO 120                                             BVI  123
      XL=XL1                                                             BVI  124
      IF (I.GT.IL) XL=XL2                                                BVI  125
120   CONTINUE                                                           BVI  126
      XMU(I)=RHO(I)*XL**2*DUDY                                           BVI  127
130   CONTINUE                                                           BVI  128
      ISAVE(1)=IL                                                        BVI  129
      SPACR(1)=XL1                                                       BVI  130
      SPACR(2)=XL2                                                       BVI  131
      SPACR(3)=XL                                                        BVI  132
      GO TO 250                                                          BVI  133
C                                                                        BVI  134
C     DONALDSON/GRAY MODEL.                                              BVI  135
```

```
C                                                                       BVI  136
140   CONTINUE                                                          BVI  137
C     LOCATE RHALF WHERE U = ( U1 + U2 ) / 2.                           BVI  138
      UT=(U(1)+U(MPSI))/2.                                              BVI  139
      DO 150 I=2,MPSI                                                   BVI  140
      IF (U(I).LT.UT) GO TO 160                                         BVI  141
150   CONTINUE                                                          BVI  142
160   RAT=(UT-U(I-1))/(U(I)-U(I-1))                                     BVI  143
      THALF=T(I-1)+RAT*(T(I)-T(I-1))                                    BVI  144
      WTHALF=WTMIX(I-1)+RAT*(WTMIX(I)-WTMIX(I-1))                       BVI  145
      CPHALF=CPBAR(I-1)+RAT*(CPBAR(I)-CPBAR(I-1))                       BVI  146
      RHALF=Y(I-1)+RAT*(Y(I)-Y(I-1))                                    BVI  147
C     CALCULATE MHALF(XMHALF).                                          BVI  148
      SS1=89517.501*WTHALF                                              BVI  149
      SS2=CPHALF/(CPHALF-SS1)                                           BVI  150
      SS=SQRT(SS2*SS1*THALF)                                            BVI  151
      XMHALF=UT/SS                                                      BVI  152
C     CALCULATE XKBAR.                                                  BVI  153
      IF (XMHALF.GT.1.2) GO TO 170                                      BVI  154
      XKBAR=0.0468+XMHALF*(-0.0460*XMHALF+0.0256*XMHALF**2)             BVI  155
      GO TO 180                                                         BVI  156
170   XKBAR=0.0248                                                      BVI  157
180   CONTINUE                                                          BVI  158
      RI=RBOT                                                           BVI  159
      EPS=XKBAR*(RHALF-RI)*ABS(U(1)-U(MPSI))/2.                         BVI  160
      DO 190 I=1,MPSI                                                   BVI  161
      XMU(I)=RHO(I)*EPS                                                 BVI  162
190   CONTINUE                                                          BVI  163
      GO TO 250                                                         BVI  164
C                                                                       BVI  165
C     KE2 TURBULENCE MODEL                                              BVI  166
C                                                                       BVI  167
200   CONTINUE                                                          BVI  168
C                                                                       BVI  169
C     CALCULATE PRODUCTION/DISSIPATION                                  BVI  170
C                                                                       BVI  171
      CMU=SPACR(5)                                                      BVI  172
      IF (CMU.EQ.0.) CMU=.09                                            BVI  173
      ZTOP=0.                                                           BVI  174
      ZBOT=0.                                                           BVI  175
      DUMA=0.                                                           BVI  176
      GUMA=0.                                                           BVI  177
      DO 210 I=2,NPSI                                                   BVI  178
      IF (XE(I).LT.1.E-20) XE(I)=1.E-20                                 BVI  179
      US1=(U(I+1)-U(I-1))/DELPSI/2.                                     BVI  180
```

```
      DUMB=RHO(I)**3*U(I)**2*Y(I)**3*XK(I)**4*USI**3/XE(I)**3/PSI(I)**2  BVI  181
      GUMB=RHO(I)*XK(I)**2*Y(I)*USI/XE(I)                               BVI  182
      DUM=(DUMA+DUMB)/2.                                                BVI  183
      GUM=(GUMA+GUMB)/2.                                                BVI  184
      ZTOP=ZTOP+DUM*DELPSI                                              BVI  185
      ZBOT=ZBOT+GUM*DELPSI                                              BVI  186
      DUMA=DUMB                                                         BVI  187
      GUMA=GUMB                                                         BVI  188
210   CONTINUE                                                          BVI  189
      DUM=DUMA/2.                                                       BVI  190
      GUM=GUMA/2.                                                       BVI  191
      ZTOP=ZTOP+DUM*DELPSI                                              BVI  192
      ZBOT=ZBOT+GUM*DELPSI                                              BVI  193
      PBAR=ZTOP/ZBOT*CMU                                                BVI  194
      IF (PBAR.LE.0.) PBAR=1.0                                          BVI  195
C                                                                       BVI  196
C     CALCULATE GFNCT(PBAR)                                             BVI  197
C                                                                       BVI  198
      IF (PBAR.LT..56) GFNCT=(8.44*PBAR-15.44)*PBAR+8.                  BVI  199
      IF (PBAR.GE..56.AND.PBAR.LT.1.) GFNCT=3.2727-PBAR/.44+(PBAR-1.)*(PBVI  200
     1BAR-.56)*(16.17-13.85*PBAR)                                       BVI  201
      IF (PBAR.GE.1..AND.PBAR.LT.3.) GFNCT=.31+.87/PBAR-.18/PBAR**2     BVI  202
      IF (PBAR.GE.3.) GFNCT=.58                                         BVI  203
      IF (GFNCT.GT.10..OR.GFNCT.LT..58) GFNCT=1.0                       BVI  204
C                                                                       BVI  205
C     CALCULATE FFNCT                                                   BVI  206
C                                                                       BVI  207
      IF (PSI(1).NE.0.) GO TO 220                                       BVI  208
      DELMIX=Y(MPSI)                                                    BVI  209
      UCL=4.*XMU(1)*(U(2)-U(1))/DELPSI**2                               BVI  210
      FFNCT=DELMIX/(U(MPSI)-U(1))/2.*(UCL-ABS(UCL))                     BVI  211
      FFNCT=ABS(FFNCT)**.2                                              BVI  212
      GO TO 230                                                         BVI  213
220   FFNCT=0.                                                          BVI  214
230   CONTINUE                                                          BVI  215
C                                                                       BVI  216
C     CALCULATE VISCOSITY                                               BVI  217
C                                                                       BVI  218
      CMU=.09*GFNCT-.0534*FFNCT                                         BVI  219
      C1=1.4                                                            BVI  220
      C2=1.94-.1336*FFNCT                                               BVI  221
      SIGK=1.0                                                          BVI  222
      SIGE=1.3                                                          BVI  223
      IL=2                                                              BVI  224
      IF (PSI(1).LE.0.) IL=1                                            BVI  225
```

```
      DO 240 I=IL,NPSI                                                  BVI  226
      XMU(I)=CMU*RHO(I)*XK(I)**2/XE(I)                                  BVI  227
      IF (XMU(I).LT.1.E-20) XMU(I)=1.E-20                               BVI  228
240   CONTINUE                                                          BVI  229
      SPACR(4)=PBAR                                                     BVI  230
      SPACR(5)=CMU                                                      BVI  231
      SPACR(6)=C1                                                       BVI  232
      SPACR(7)=C2                                                       BVI  233
250   CONTINUE                                                          BVI  234
      A(1)=0.                                                           BVI  235
      IL=1                                                              BVI  236
      IF (PSI(1).LE.0.) IL=2                                            BVI  237
      DO 260 I=IL,MPSI                                                  BVI  238
      A(I)=XMU(I)*RHO(I)*U(I)*Y(I)**2/PSI(I)                            BVI  239
      IF (A(I).LT.1.E-20) A(I)=1.E-20                                   BVI  240
260   CONTINUE                                                          BVI  241
      RETURN                                                            BVI  242
      END                                                               BVI  243
```

```
      FUNCTION BOATAW (J, I)                                                    BAW     1
C                                                                               BAW     2
C       BOATAW - ALPHA/WTMIX                                                    BAW     3
C                                                                               BAW     4
C       BOATCM - BOAT COMMON                                                    BAW     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),          BAW     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),             BAW     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),           BAW     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),          BAW     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),         BAW    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),              BAW    11
     6 VJET(4,25,2), WOUT(25,50), WM(25), WP(25), WTMIX(50), WTMULE(25),        BAW    12
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),             BAW    13
     8 YOUT(50), ZID(5)                                                         BAW    14
C                                                                               BAW    15
      LOGICAL LHALF,LSWON                                                       BAW    16
C                                                                               BAW    17
      EQUIVALENCE (J1, J12345(1))                                               BAW    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                          BAW    19
      EQUIVALENCE (ECC, CP(1,13)), (YOUT, CM(1,15))                             BAW    20
      EQUIVALENCE (CPTBV, CGHV)                                                 BAW    21
      EQUIVALENCE (HCP(1,1), WM(1))                                             BAW    22
      EQUIVALENCE (START, TTB(1))                                               BAW    23
C                                                                               BAW    24
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                      BAW    25
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BAW    26
     1        CRR     ,  CVISC ,  DELPSI ,  DFOL   ,  DPDX   ,  DX     ,BAW    27
     2        DXMIN   ,  FOL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BAW    28
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BAW    29
     4        IPAGE   ,  IPRFSS ,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,BAW    30
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BAW    31
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BAW    32
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BAW    33
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BAW    34
     9        QX      ,  RALPHA ,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BAW    35
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BAW    36
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BAW    37
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BAW    38
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BAW    39
     5        WTMIX   ,  WTMULE ,  X      ,  XCHANG ,  XD     ,  XE     ,BAW    40
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BAW    41
     7        Y       ,  ZID                                              BAW    42
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)             BAW    43
C                                                                               BAW    44
C       JET/EXT FLOW FIELD COMMON SECTION                                       BAW    45
```

```
C
      COMMON  DELJ   , DELE   , IJET   , IEXT   , IMAXJ  , IMAXE  ,BAW    46
     1        KMAXJ  , KMAXE  , NRJET  , NREXT  , PSJET  , PSEXT  ,BAW    47
     2        P1     , P2     , P3     , P4     , USTJ   , USTE   ,BAW    48
     3        VJET   , VFXT   , XJET   , XEXT                      ,BAW    49
                                                                     BAW    50
C                                                                    BAW    51
      COMMON  ENDCM                                                  BAW    52
C                                                                    BAW    53
C     END OF COMMON TO BE COPIED TO RESTART FILE                     BAW    54
C                                                                    BAW    55
      COMMON  FID(3,5), IFNAM(3), LSWON(16)                          BAW    56
C                                                                    BAW    57
C                                                                    BAW    58
      BOATAW = ALPHA(J,I)/WTMIX(I)                                   BAW    59
      RETURN                                                         BAW    60
      END                                                            BAW    61
```

```
      FUNCTION BOATEF (K,NJ,RPT)                                                BEF     1
C                                                                               BEF     2
C     BOATEF - CALCULATE F USED IN BOATS2                                       BEF     3
C                                                                               BEF     4
C      BOATCM - BOAT COMMON                                                     BEF     5
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),          BEF     6
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),             BEF     7
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),           BEF     8
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),          BEF     9
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),         BEF    10
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),              BEF    11
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),BEF    12
     7 XE(50), XEXT(50), XJET(50), XP(50), XLE(50), XMU(50), Y(50),             BEF    13
     8 YOUT(50), ZID(5)                                                         BEF    14
C                                                                               BEF    15
      LOGICAL LHALF,LSWON                                                       BEF    16
C                                                                               BEF    17
      EQUIVALENCE (J1, J12345(1))                                               BEF    18
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                          BEF    19
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                             BEF    20
      EQUIVALENCE (CPTBV, CGHV)                                                 BEF    21
      EQUIVALENCE (HCP(1,1), WM(1))                                             BEF    22
      EQUIVALENCE (START, TTB(1))                                               BEF    23
                                                                                BEF    24
C                                                                               BEF    25
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                      BEF    26
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,BEF    27
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,BEF    28
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,BEF    29
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,BEF    30
     4        IPAGE   ,  IPRESS ,  IRR   ,  IRRR   ,  IRT    ,  ISAVE  ,BEF    31
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,BEF    32
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,BEF    33
     7        MPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,BEF    34
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,BEF    35
     9        QX      ,  RALPHA ,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,BEF    36
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,BEF    37
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,BEF    38
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,BEF    39
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,BEF    40
     5        WTMIX   ,  WTMOLE ,  X     ,  XCHANG ,  XD     ,  XE     ,BEF    41
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,BEF    42
     7        Y       ,  ZID                                              BEF    43
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)           BEF    44
C                                                                         BEF    45
C     JET/EXT FLOW FIELD COMMON SECTION
```

```
C                                                                       BEF    46
      COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE  ,BEF    47
     1        KMAXJ   ,  KMAXE   ,  NPJET   ,  NREXT   ,  PSJET   ,  PSEXT  ,BEF    48
     2        P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE   ,BEF    49
     3        VJET    ,  VEXT    ,  XJET    ,  XEXT                          BEF    50
                                                                            BEF    51
C                                                                           BEF    52
      COMMON  ENDCM                                                         BEF    53
C                                                                           BEF    54
C     END OF COMMON TO BE COPIED TO RESTART FILE                            BEF    55
C                                                                           BEF    56
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                               BEF    57
C                                                                           BEF    58
C                                                                           BEF    59
      E=0.0                                                                 BEF    60
      SIGN=1.0                                                              BEF    61
      DO 10 N=1,NJ                                                          BEF    62
      IF (N.EQ.2.AND.K.EQ.5) GO TO 10                                       BEF    63
      IF (N.GT.2) SIGN=-1.0                                                 BEF    64
      J=J12345(N)                                                           BEF    65
      E=SIGN*G(J)+E                                                         BEF    66
10    CONTINUE                                                              BEF    67
C                                                                           BEF    68
      E=E/RRT                                                               BEF    69
      IF (ABS(E).LT.80.) GO TO 30                                           BEF    70
      IF (E.LT.0.0) GO TO 20                                                BEF    71
      IF (E.GT.0.0) E=EXP(80.0)                                             BEF    72
      GO TO 40                                                              BEF    73
20    E=EXP(-80.0)                                                          BEF    74
      GO TO 40                                                              BEF    75
30    E=EXP(E)                                                              BEF    76
40    BOATEF=E                                                              BEF    77
      RETURN                                                                BEF    78
      END
```

```
      FUNCTION ETIME (STIME)
C
C      ELAPSED TIME FUNCTION
C
       ETIME = SECOND (STIME)/60.
       RETURN
       END
```

```
ETI     1
ETI     2
ETI     3
ETI     4
ETI     5
ETI     6
ETI     7
```

```
      FUNCTION NFWAB (A, B)                                              NFW     1
C                                                                        NFW     2
CC    NFWAB - NUMBER OF STANDARD FORTRAN WORDS FROM A TO B               NFW     3
C                                                                        NFW     4
      NFWAB = LOCF(B) - LOCF(A)                                          NFW     5
      RETURN                                                             NFW     6
      END                                                                NFW     7
```

```
      FUNCTION SMPR2(N,A1,A2)                                    SMP     1
      DIMENSION A1(1), A2(1)                                     SMP     2
      SUM = 0.0                                                  SMP     3
      DO 10 I=1, N                                               SMP     4
      SUM = SUM + A1(I)*A2(I)                                    SMP     5
10    CONTINUE                                                   SMP     6
      SMPR2 = SUM                                                SMP     7
      RETURN                                                     SMP     8
      END                                                        SMP     9
```

```
      SUBROUTINE PBFDR (DUMMY, NRO, NWO, VEC)                                  PDR     1
                                                                               PDR     2
C                                                                              PDR     3
C     DUMMY DISK READ ROUTINE - MAY BE REPLACED BY                             PDR     4
C     REAL DISK READ ROUTINE.                                                  PDR     5
C                                                                              PDR     6
C       BOATCM - BOAT COMMON                                                   PDR     7
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),         PDR     8
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),            PDR     9
     2 HCP(2,25), HSTAT(50), HTBV(750), IRR(40), IRRR(40,5), IRT(40),          PDR    10
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),         PDR    11
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),        PDR    12
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),             PDR    13
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),       PDR    14
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),            PDR    15
     8 YOUT(50), ZID(5)                                                        PDR    16
C                                                                              PDR    17
      LOGICAL LHALF,LSWON                                                      PDR    18
C                                                                              PDR    19
      EQUIVALENCE (J1, J12345(1))                                              PDR    20
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                         PDR    21
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                            PDR    22
      EQUIVALENCE (CPTBV, CGHV)                                                PDR    23
      EQUIVALENCE (HCP(1,1), WM(1))                                            PDR    24
      EQUIVALENCE (START, TTB(1))                                              PDR    25
C                                                                              PDR    26
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                     PDR    27
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,PDR    28
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,PDR    29
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,PDR    30
     3        IDELP   ,  IECC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,PDR    31
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,PDR    32
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,PDR    33
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,PDR    34
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,PDR    35
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,PDR    36
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,PDR    37
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,PDR    38
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,PDR    39
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,PDR    40
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,PDR    41
     5        WTMIX   ,  WTMOLE,  X      ,  XCHANG ,  XD     ,  XE     ,PDR    42
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,PDR    43
     7        Y       ,  ZID                                              PDR    44
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)                PDR    45
C
```

```
C      JET/EXT FLOW FIELD COMMON SECTION                                  PDR    46
C                                                                         PDR    47
       COMMON  DELJ    ,  DELE    ,  IJET    ,  IEXT    ,  IMAXJ   ,  IMAXE   ,PDR    48
     1         KMAXJ   ,  KMAXE   ,  NPJET   ,  NREXT   ,  PSJET   ,  PSEXT   ,PDR    49
     2         P1      ,  P2      ,  P3      ,  P4      ,  USTJ    ,  USTE    ,PDR    50
     3         VJET    ,  VEXT    ,  XJET    ,  XEXT                          PDR    51
C                                                                         PDR    52
       COMMON  ENDCM                                                      PDR    53
C                                                                         PDR    54
C      END OF COMMON TO BE COPIED TO RESTART FILE                         PDR    55
C                                                                         PDR    56
       COMMON  FID(3,5),  IFNAM(3),  LSWCN(16)                            PDR    57
C                                                                         PDR    58
C                                                                         PDR    59
       CALL SFVMV (FLJTEX(NP0), VEC, NWO)                                 PDR    60
       NRO = NRO+NWO                                                      PDR    61
       RETURN                                                             PDR    62
       END                                                                PDR    63
```

```
      SUBROUTINE PBFDW (DUMMY, NRO, NWO, VEC)                                  PDW     1
C                                                                              PDW     2
C     DUMMY DISK WRITE ROUTINE - MAY BE REPLACED BY                            PDW     3
C     REAL DISK WRITE ROUTINE.                                                 PDW     4
C                                                                              PDW     5
C       BOATCM - BOAT COMMON                                                   PDW     6
      DIMENSION A(50), AID(25), ALOC(50,6), ALPHA(25,50), CGHV(750,3),         PDW     7
     1 CM(25,25), CPBAR(50), CPTBV(750), ECC(50), G(25), GTBV(750),            PDW     8
     2 HCP(2,25), HSTAT(50), HTBV(750), IRP(40), IRRR(40,5), IRT(40),          PDW     9
     3 ISAVE(6), J12345(5), PSEXT(50), PSI(50), QX(25), RALPHA(25,50),         PDW    10
     4 RC(40,3), RHO(50), RHOOUT(50), RT(50), RU(50), RXE(50), RXK(50),        PDW    11
     5 SIGMA(50), START(1), T(50), TITLE(18), U(50), VEXT(4,25,2),             PDW    12
     6 VJET(4,25,2), WDOT(25,50), WM(25), WP(25), WTMIX(50), WTMOLE(25),PDW    13
     7 XE(50), XEXT(50), XJET(50), XK(50), XLE(50), XMU(50), Y(50),            PDW    14
     8 YOUT(50), ZID(5)                                                        PDW    15
C                                                                              PDW    16
      LOGICAL LHALF,LSWON                                                      PDW    17
C                                                                              PDW    18
      EQUIVALENCE (J1, J12345(1))                                              PDW    19
      EQUIVALENCE (ALOC(1,1), CM(1,1))                                         PDW    20
      EQUIVALENCE (ECC, CM(1,13)), (YOUT, CM(1,15))                            PDW    21
      EQUIVALENCE (CPTBV, CGHV)                                                PDW    22
      EQUIVALENCE (HCP(1,1), WM(1))                                            PDW    23
      EQUIVALENCE (START, TTB(1))                                              PDW    24
C                                                                              PDW    25
      COMMON  TTB(30),  HF(25) ,  CPTBV  ,  GTBV   ,  HTBV                     PDW    26
      COMMON  A       ,  AID   ,  ALPHA  ,  CARB   ,  CM     ,  CPBAR  ,PDW    27
     1        CRR     ,  CVISC ,  DELPSI ,  DFDL   ,  DPDX   ,  DX     ,PDW    28
     2        DXMIN   ,  FDL   ,  FFF    ,  G      ,  GGG    ,  HSTAT  ,PDW    29
     3        IDELP   ,  IFCC  ,  IFINIS ,  IOUT   ,  IOUT1  ,  IOUT2  ,PDW    30
     4        IPAGE   ,  IPRESS,  IRR    ,  IRRR   ,  IRT    ,  ISAVE  ,PDW    31
     5        ITFLG   ,  IVIS  ,  J1     ,  J2     ,  J3     ,  J4     ,PDW    32
     6        J5      ,  LHALF ,  MMOD   ,  MPSI   ,  MXNPT  ,  MXNP1  ,PDW    33
     7        NPSI    ,  NR    ,  NRAD   ,  NRAS   ,  NS     ,  NT     ,PDW    34
     8        P       ,  PCNT  ,  PRNT   ,  PRNTXC ,  PSI    ,  PSID   ,PDW    35
     9        QX      ,  RALPHA,  RBUOY  ,  RC     ,  RHO    ,  RHOOUT ,PDW    36
     1        RJ      ,  RT    ,  RTACU  ,  RTJAC  ,  RTJOB  ,  RTMAX  ,PDW    37
     2        RU      ,  RXE   ,  RXK    ,  SIGE   ,  SIGK   ,  SIGMA  ,PDW    38
     3        T       ,  TCONT ,  TEDGE  ,  TEMRM  ,  TEMRP  ,  TITLE  ,PDW    39
     4        TKINET  ,  U     ,  UNIT   ,  WDOT   ,  WM     ,  WP     ,PDW    40
     5        WTMIX   ,  WTMOLF,  X      ,  XCHANG ,  XD     ,  XE     ,PDW    41
     6        XINIT   ,  XK    ,  XK2    ,  XLE    ,  XMAX   ,  XMU    ,PDW    42
     7        Y       ,  ZID                                                   PDW    43
      COMMON  FLJTEX(10000),  NAMAS(3),  RPRM(2400),  SPACR(10)                PDW    44
C                                                                              PDW    45
```

```
C     JET/FXT FLOW FIELD COMMON SECTION                                                  PDW   46
C                                                                                        PDW   47
      COMMON  DELJ    , DELE    , IJET    , IEXT    , IMAXJ   , IMAXE   ,PDW   48
     1        KMAXJ   , KMAXF   , NRJET   , NREXT   , PSJET   , PSEXT   ,PDW   49
     2        P1      , P2      , P3      , P4      , USTJ    , USTE    ,PDW   50
     3        VJET    , VEXT    , XJET    , XEXT                         PDW   51
C                                                                                        PDW   52
      COMMON  ENDCM                                                                      PDW   53
C                                                                                        PDW   54
C     END OF COMMON TO BE COPIED TO RESTART FILE                                         PDW   55
C                                                                                        PDW   56
      COMMON  FID(3,5),  IFNAM(3),  LSWON(16)                                            PDW   57
C                                                                                        PDW   58
C                                                                                        PDW   59
      CALL SFVMV (VEC, FLJTEX(NRO), NWO)                                                 PDW   60
      NRO = NRO+NWO                                                                      PDW   61
      RETURN                                                                             PDW   62
      END                                                                                PDW   63
```

```
      SUBROUTINE SFVFL (VAL, VEC, NW)                                   FVF     1
C                                                                       FVF     2
C     SFVFL - STANDARD FORTRAN VECTOR FILL                              FVF     3
C                                                                       FVF     4
      DIMENSION VEC(1)                                                  FVF     5
      DO 10 I = 1, NW                                                   FVF     6
      VEC(I) = VAL                                                      FVF     7
 10   CONTINUE                                                          FVF     8
      RETURN                                                            FVF     9
      END                                                               FVF    10
```

```
      SUBROUTINE SFVMV (VEC1, VEC2, NW)                                 FVM     1
C                                                                       FVM     2
C     SFVMV - STANDARD FORTRAN VECTOR MOVE                              FVM     3
C                                                                       FVM     4
      DIMENSION VEC1(1), VEC2(1)                                        FVM     5
      DO 10 I = 1, NW                                                   FVM     6
      VEC2(I) = VEC1(I)                                                 FVM     7
   10 CONTINUE                                                          FVM     8
      RETURN                                                            FVM     9
      END                                                               FVM    10
```